# Screening Level Ecological Risk Assessment Work Plan



**General Dynamics Ordnance and Tactical Systems Munitions Services**
**Joplin, Missouri**

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# Screening Level Ecological Risk Assessment Work Plan
# General Dynamics Ordnance and Tactical Systems Munitions Facility

**Joplin, Missouri**

Prepared for:

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## 1. INTRODUCTION

The Missouri Department of Natural Resources (MDNR) has requested that General Dynamics-OTS Munition Services (GD-OTS MS) perform a multipathway screening level ecological risk assessment (SLERA) pursuant to the current Resource Conservation and Recovery Act (RCRA) Permit. This work plan will accompany the update of the *Human Health Risk Assessment Work Plan* (*HHRA Work Plan*) originally produced for the GD-OTS MS facility (Site) by ENSR/AECOM (2008). This multipathway SLERA will evaluate the potential for unacceptable ecological risk resulting from direct and indirect exposure to air emissions associated with the operation of three buildings at the GD-OTS MS facility in Carthage, Missouri. These buildings are: 1) Building 1 - MLRS/ ICM Disassembly building; 2) Building 3 - Propellant Thermal Treatment Process; and 3) Building 6 - Incineration Complex. Consistent with this request, GD-OTS MS has prepared this work plan for conducting a SLERA. The purpose of this work plan is to establish an approach for the SLERA and describe the general methodology that will be used to conduct an assessment of the potential ecological risk that could result from either direct or indirect exposure to emissions associated with Buildings 1, 3, and 6.

In general, the SLERA will be conducted in accordance with USEPA ecological risk assessment guidance, including *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997) and *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities – Peer Review Draft* (USEPA 1999) and will consider multiple pathways of exposure. Examples of potential exposure pathways include direct contact with and incidental ingestion of constituents emitted from Buildings 1, 3, and 6 that have been deposited onto soil or surface water features, and ingestion of trace levels of constituents that may enter the food chain through deposition from the air to soil and watercourses in the vicinity of the facility. Potential exposures and associated risks to ecological receptors will be evaluated using the conservative assumptions recommended by USEPA ecological risk assessment guidance (USEPA 1997; 1999).

To evaluate potential ecological risk from facility stack emissions, mathematical models will be used to calculate the anticipated atmospheric dispersion and deposition of emissions from Building 1, 3, and 6. The air dispersion and deposition modeling results will then be entered into the Lakes Environmental Software model, IRAP-h View (Version 4.0) (Lakes Environmental 2012), which will provide the basis for estimating exposure concentrations in each ecologically relevant exposure medium. Potential ecological receptors and exposure pathways are based on an evaluation of the environmental setting, the likely suitability of habitats for supporting ecological populations and communities of organisms, and the potential for deposition of facility-related emissions onto media in suitable habitat near the facility.

### 1.1 SLERA WORK PLAN ORGANIZATION

This *SLERA Work Plan* addresses potential ecological exposures resulting from facility-related emissions of constituents. Section 2.0 characterizes the Site combustion sources and waste handling process, identifies chemicals that will be evaluated quantitatively in the SLERA, and establishes the procedure for estimating chemical-specific emission and deposition rates. Section 3.0 presents the approach for dispersion and deposition modeling. Section 4.0 presents the screening level problem formulation, which culminates in the development of an ecological conceptual site model (CMS) that describes the linkages between the contaminant source (Buildings 1, 3, and 6) and ecological receptors. Section 5.0 describes the screening level exposure assessment and presents the methodologies for quantifying direct contact and food chain exposures to ecological receptors. Section 6.0 discusses the screening level ecological effects characterization, which identifies the sources of ecotoxicity values that will be used for evaluating ecological effects. Section 7.0 establishes the ecological risk characterization approach, which couples the exposures estimates with the ecotoxicity values to derive risk, and describes how uncertainties will be addressed. Section 9.0 presents the references for documents cited in this *SLERA Work Plan*.

## 2. CHARACTERIZING FACILITY EMISSIONS

The GD-OTS MS Joplin facility, constructed in 1994, treats reactive waste generated by the explosives manufacturing industry, users of explosive devices and materials, and government agencies. The facility is located in rural Jasper County, Missouri, on County Road 180 about 3 kilometers (km) north of U.S. Interstate 44 (**Figures 1** and **2**) and is part of the Tri-State Mining District that was an active zinc-lead mining area until 1957.

The USEPA facility ID #, Mailing Address, and Primary Contact are presented below.

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### 2.1 BASIC FACILITY INFORMATION

The GD-OTS MS facility consists of numerous operating buildings and areas, and storage magazines, located within a 55-acre site. The discussion in this section is limited to the buildings that contain thermal treatment units (Buildings 1, 3, and 6; **Figure 3**). Refer to Appendix A for a description of all Site buildings.

#### 2.1.1 Building No. 1 MLRS/ICM Disassembly Building

The MLRS/ICM Disassembly Building consists of two separate areas, a non-RCRA regulated disassembly area, and a RCRA Subpart X thermal treatment area. In the non-RCRA area, military munitions are downloaded in safety cells and the submunitions disassembled using unattended, automated equipment to remove and disassemble the submunitions. Disassembled submunitions are subsequently treated thermally in the RCRA Subpart X area of the building.

The RCRA Subpart X thermal treatment area consists of four Contained Thermal Treatment Chambers (CTTC) where the explosives in the submunitions are ignited by natural gas fired torches and allowed to burn in the chambers. There also are four electrically-heated Static Kilns (SK) in which the fuzes from the submunitions are thermally treated. Emissions from the thermal treatment of the explosives in the submunitions and fuzes are controlled by Air Pollution Control Systems (APCS) servicing the thermal treatment processes.

The body of the submunition contains 17% (30 grams) of explosive material and no RCRA regulated chemicals. The submunition body is placed in a fixture on a conveyor that runs through a CTTC. The explosive material in the body is ignited by a natural gas fired torch and allowed to burn. All of the explosive material in each body is consumed in about 1 minute. Clean scrap metal is collected in the residuals area of this process. The chambers are held at a negative pressure by an induced draft fan on the APCS through which the emissions are pulled for cleaning. The CTTC APCS consists of a Primary Cartridge Filter, and a H13 HEPA Filter to remove the very small amount of particulates that are generated by the burning explosives, and an Induced Draft Fan to pull all emission from the chambers thru the APCS to the Stack.

The second part of the submunition is the fuze that contains <1% (88 milligrams) explosive material with less than 0.38% lead. This fuze is conveyed into a separate chamber where it is dropped into an electrically heated SK. The heat from the electric heater on the outside of the SK causes the explosive materials to ignite. The emissions from the burning of the explosive material may include a minute amount of lead, which is pulled into the SK APCS for cleaning. Since the SK is a batch type unit, GD-OTS MS has four SKs with the emission going to the APCS referenced above. Only one SK is operated at a time. While the one kiln is in operation and reaching filling capacity, a second SK is heated in preparation for receiving the fuzes for thermal treatment. A third SK would be in the process of cooling down from completion of a batch treatment prior to opening the SK and removing the metal residue. A fourth SK is used as backup during routine maintenance of the SKs. The APCS for the SKs is a Primary Cartridge Filter and H13 HEPA Filter, with an induced draft fan to pull all emissions from the SKs through the APCS to the Stack.

### 2.1.2 Building No. 3 Propellant Thermal Treatment Process

The Propellant Thermal Treatment Process is a RCRA Subpart X regulated process for disposal of the MLRS rocket motors. It consists of a Preparation Bay, two Saw Bays, a Transfer Room, two Propellant Thermal Treatment Chambers (PTTC), and an APCS. The Rocket Motor contains 216.5 pounds of a case bonded Ammonium Perchlorate based propellant. In this process, the MLRS rocket motors are cut into segments using underwater saws. The cut segments are transferred from the saw bays into a Transfer Room, then into one of the two PTTCs where they are ignited using a natural gas fired torch. The torch ignites the propellant which is allowed to burn in the rotary conveyor inside of the PTTC. Clean scrap metal is collected in containers. The chamber is held at a negative pressure by an induced draft fan on the APCS through which the emissions are pulled.

The APCS consists of a Quench Chamber to cool the gases and to inject the sodium bicarbonate to neutralize the chlorine and acid gases, a Reaction Chamber (former Spray Dryer) to increase the neutralization and where activated carbon is injected for organics removal, a Baghouse to filter the particulates and a Wet Scrubber to complete the neutralization and particulate filtration of the exhaust gases. An Induced Draft Fan pulls all emission from the chambers thru the APCS to the Stack.

### 2.1.3 Building No. 6 Incineration Complex

The Incineration Complex consists of two incinerators. The hazardous waste handling operations are performed in accordance with RCRA regulations. The Incineration Complex consists of a Control Room, Feed Room, Kiln Containment Room, Residuals Handling Room, 90-Day Storage Area, Air Pollution Control System Area, Induced Draft Fan Area, Controlled Emissions Monitoring Building, Utilities Building, and Car Bottom Furnace.

The Control Room is where the incineration process and feeding operations are controlled for the Rotary Kiln Incinerator (RKI) and Car Bottom Furnace (CBF). This room is adjacent to the Feed Room and the Kiln Containment Room, separated by concrete blast walls. All operational controls for the incineration plant, consisting of a redundant Distributed Control Systems (DCS), are located in the Control Room. Plant operators observe the kiln feeding operation via closed-circuit television (CCTV) monitors. In addition, the Control Room monitors all other operations in the Plant Operations Area using CCTV monitors, including operations at the Magazines. There are numerous CCTV Cameras located throughout all of the plant operations. Multiple monitors are located in the Control Room by which plant operations are monitored.

Waste from magazines or from the Storage/Feed Handling Building is loaded onto a transport vehicle for carrying the waste to the Feed Room. A maximum volume of waste sufficient for up to four hours of incineration operation is moved at one time. The unloading area is covered by a metal roof. The unloading pad is concrete with berms to contain all spills. Wastes are introduced into the RKI from the Feed Room.

The Kiln Containment Room houses the charge conveyor, the RKI, and portions of the feed conveyor and the discharge skip hoist.

The Residuals Handling Room contains a vibrating conveyor for separating the ash and metals discharged from the RKI. Metals are recovered for recycling and ash is collected for disposal as hazardous waste in a permitted HW landfill.

The 90-Day Storage Area is a curbed concrete pad within a three-sided metal building. A drain from the concrete pad is connected to the APCS area collection sump to control spills and precipitation. Ash residuals for disposal are dumped into ash roll-off containers for transport to an off-site, permitted, hazardous waste landfill for disposal. A residuals sampling program is utilized to ensure proper disposal of all residuals. Residual metals are inspected in this area to ensure they have been inerted by the incineration process. Residual metals are dumped in roll-off bins for removal from the site and transport to commercial recycling facilities.

***Building 6 - Air Pollution Control System Area***

The APCS area includes the Secondary Combustor, Spray Dryer, Baghouses and support equipment. After exiting the RKI or the CBF, the exhaust gas enters the Secondary Combustor, where the gas is heated to 1800 - 2200°F by burning natural gas auxiliary fuel. This elevated temperature, in conjunction with the gas residence time of greater than four seconds, ensures the complete destruction of organic materials. After exiting the Secondary Combustor, the exhaust gas then enters the Spray Dryer into which soda ash slurry is sprayed to remove acid gases as well as to cool the exhaust to the operating temperature range of the Baghouse. The exhaust gases leaving the Spray Dryer are then sent to the Baghouses. The dust collected on the bags is removed by reverse pulses of compressed air being applied to the inside of the bags. The dust falls to the bottom of the Baghouse where it is removed through a rotary valve. The dust is placed in the ash roll-off and sent to a RCRA-approved hazardous waste landfill.

All of the APCS equipment is located on a curbed concrete pad which is sealed with an epoxy coating to prevent leakage of water from the pad. Rain water and any other water that falls on the APCS pad flows into the Sump where it is pumped into Tank TK-103 from which it is pumped for use in the spray dryer as quench water. In this manner, no liquid effluent from the APCS leaves the plant.

Two parallel induced draft fans are provided to move the exhaust gas to the stack. Each fan is designed to handle 100 percent of the total gas flow. Both fans are generally operated at the same time, unless it is necessary to shut down one of the fans for maintenance. The stack is 65 meters in height.

The Continuous Emissions Monitoring Building is located at the base of the stack. Located in the building is the sampling equipment that continuously monitors the stack gases for carbon monoxide, hydrocarbons, oxygen, opacity, and stack flow rate/temperature.

The Utilities Building houses the Soda Ash Tanks where soda ash is mixed and metered to the spray dryer in the APCS for acid gas control. It also houses the air compressors that provide compressed air supply for operating the plant, an emergency backup generator for supplying electricity to allow an ordered shutdown of the plant in the event of an electrical power failure, and the electrical motor control center.

***Building 6 - Car Bottom Furnace***

The CBF is a natural gas fired incinerator designed to decontaminate large, unusual or irregular shaped metal pieces and incinerate contaminated combustible materials such as rags, coveralls, and packaging materials. The furnace system consists of a CBF, Overhead Hoist, Car Bottom Furnace Track Scale and a Car Bottom Furnace Baskets.

## 2.2 IDENTIFYING EMISSION SOURCES AND ESTIMATING EMISSION RATES

The emission sources at the GD-OTS MS facility have been well characterized and consist of the operation of three processing buildings with thermal treatment units: 1) Building 1 (one SKS, four identical CTTCs); 2) Building 3 (PTTC); and 3) Building 6 (RKI and CBF). The following sections describe the stack emissions, potential upset emissions, and RCRA fugitive emissions from these units.

Prior to discussing these factors, GD-OTS MS wishes to highlight two constituents that have not been evaluated in any Comprehensive Performance Tests (CPT) to date: aluminum and hexavalent chromium.

Aluminum: Prior to the conduct of the air dispersion modeling and the risk assessments, the emissions from Building 3 will be tested for Aluminum. The emissions from Buildings 1 and 6 will not undergo testing for this constituent. This decision is based on the fact that the waste processed in Building 3 typically contains aluminum while the waste processed in Building 1 does not. As only a small fraction of the feed stock for Building 6 contains aluminum, the emissions from this facility will not be tested for this constituent.

Chromium: To date, chromium emissions from all three subject buildings have not been speciated (i.e., hexavalent chromium emissions are unknown). Chromium is most toxic to ecological receptors in its trivalent form. Therefore, as a conservative measure, all chromium emitted from these buildings will be assumed to be in the trivalent form in the SLERA. If the risk and hazard estimates that result from this conservative assumption exceed acceptable thresholds then additional information (e.g., results of facility ash analyses and existing literature) will be used in the uncertainty section of the SLERA to discuss the most likely speciation of this element and how this speciation would impact risk estimates.

### 2.2.1 Estimating Stack Emissions for Existing Facilities

The information in the following sections provides a short summary of the Comprehensive Performance Tests (CPT) for the emission units associated with the subject buildings. The results of the CPTs will be used to develop the Compound of Potential Concern (COPC)-specific emission rates that will serve as an input into the IRAP-h View model. These COPC-specific emission rates have not been developed as of the writing of this *SLERA Work Plan*. General Dynamics proposes to develop these emission rates in accordance with the USEPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (HHRAP) guidance (USEPA 2005a) and submit the proposed factors to the USEPA and the MDNR as an interim deliverable prior to running the IRAP-h View model.

***Building 1***

The emission units housed in Building 1 include one SK System and four identical CTTUs. The CPT for the SK and CTTCs was conducted during the week of June 25-29, 2012 in accordance with an approved CPT Plan and under full oversight of USEPA Region 7 and the MDNR. This CPT was designed to address the permit requirements for these emission units and included feeding the maximum quantities of the specified waste into each thermal treatment system, characterization of these feedstreams, monitoring of certain process parameters and conducting emissions testing. The following COPCs were evaluated during this CPT: dioxins and furans, semi-volatile metals (arsenic, chromium and beryllium), low volatile metals (lead and cadmium), particulate matter, mercury, hydrogen chloride, and chlorine gas.

***Building 3***

The emission units housed in Building 3 include the PTTU. The CPTs for the PTTU were conducted in accordance with an approved CPT Plan and under full oversight of USEPA Region 7 and the MDNR. The CPT was also conducted at a single set of operating conditions that included feeding the maximum quantities of the specified waste into the thermal treatment system while operating the APCS at worst case conditions.

The initial CPT for the PTTU was conducted during the week of April 23-27, 2012 for dioxins and furans, semi-volatile metals (arsenic, chromium and beryllium), low volatile metals (lead and cadmium), particulate matter, hydrogen chloride, and chlorine gas. Results from the initial CPT showed that all emission standards were met with the exception of dioxin and furan emissions which exceeded the RCRA Permit emission limit. Accordingly, a retest was performed during the week of May 28–June 1, 2012 and again test results were above the RCRA Permit limit. A third dioxin and furan test program was conducted during the week of June 18-22, 2012. Triplicate test runs were conducted at two conditions that involved operating the newly installed activated carbon system at two different injection rates. Dioxin and furan emissions at both test conditions were within the RCRA Permit limits.

***Building 6***

The emission units housed in Building 6 include the RKI and CBF. The CPT for these units was conducted during the week of June 13, 2011 in accordance with an approved CPT Plan and under full oversight of the MDNR. The CPT was conducted at a single set of operating conditions that included feeding the maximum quantities of the specified waste into the thermal treatment system while operating the APCS at worst case conditions. The following COPCs will be evaluated during this CPT: dioxins and furans, semi-volatile metals (arsenic, chromium and beryllium), low volatile metals (lead and cadmium), particulate matter, hexachloroethane, naphthalene, total hydrocarbons, hydrogen chloride, and chlorine gas.

### 2.2.2 Emissions from Process Upsets

USEPA guidance suggests that upset emissions may result from upsets in the hazardous waste combustion process. Upset emissions are generally expected to be greater than stack emissions because the process upset results in incomplete destruction of the wastes or other physical or chemical conditions within the combustion system that promote the formation and/or release of hazardous compounds from combustion stacks. Upset emissions usually occur during events and times when the hazardous waste combustion unit is not operating within the limits specified in a permit or regulation.

The HHRAP indicates that, if available, information on the frequency, duration and causes of automatic waste feed cutoffs (AWFCOs) can be utilized to derive site-specific upset emission factors. Since the emission units and APCSs associated with Buildings 1, 3, and 6 have been in operation for a significant period of time, records of process upsets and continuous monitoring of stack gas parameters such as carbon monoxide will be used to establish upset factors that are representative of each building. These building-specific upset factors have not been developed as of the writing of this *SLERA Work Plan*. GD-OTS MS proposes to develop these upset factors in accordance with the various guidance documents listed in Section 2.2.5 of the HHRAP (USEPA 2005a) and submit these upset factors (and the rationale for their development) to the USEPA and MDNR as an interim deliverable prior to running the IRAP-h View model.

### 2.2.3 RCRA Fugitive Emissions

Fugitive emissions are typically associated with the release of compounds or pollutants from leaks in combustion chambers (*e.g.*, "puffs"); tanks, valves, flanges, and other material handling equipment used in the storage and handling of RCRA hazardous wastes as part of the combustion process. However, Buildings 1, 3, and 6 are unique because the combustion units are located in enclosed rooms where the air is exhausted through a bank of filters specifically designed to control fugitive emissions.

Off-design fugitive emissions are not expected to escape from Buildings 1, 3, and 6 for the following reasons:

- The waste that is thermally treated in these building is a solid material consisting of cluster munitions, grenades, fuses, rocket motors, etc.;
- The volatility of these munitions and munitions components is so low that no special PPE is required for operators handling the devices;
- The treatment chambers, ductwork, and primary filters are all maintained under negative pressure by the induced draft fan (the only part of the APCS that is not under negative pressure is the HEPA filter and activated carbon filter).

Although it is not possible to completely eliminate all transient pressure spikes in the thermal treatment chambers, the engineering features of the thermal treatment systems and their associated APCSs virtually eliminate the potential for fugitive emissions. The potential for fugitive emissions from these facilities is limited to those that could potentially escape during unintended periods of poor operating conditions resulting from malfunction, error, power failure or other unpredictable events. However, such occurrences will be treated as true "upsets" and dealt with by the application of an upset factor (see Section 2.2.2 above) if necessary. Therefore, fugitive emissions from Buildings 1, 3, and 6 will not be addressed in the SLERA.

## 2.3 IDENTIFYING COMPOUNDS OF POTENTIAL CONCERN

The primary source of emissions data used to select COPCs will be measurement results obtained from the CPTs for Buildings 1, 3, and 6. The CPTs for the subject buildings were conducted in accordance with approved *CPT Work Plans* and under full oversight of USEPA Region 7 and the MDNR.

The CPTs sampled the gases discharged from the exhaust stacks for the following parameters:

*Building 1*: dioxins and furans, SVOC emissions, total hydrocarbons, semi-volatile metals (arsenic, chromium and beryllium), low volatile metals (lead and cadmium), particulate matter, mercury, hydrogen chloride, and chlorine gas

*Building 3:* dioxins and furans, semi-volatile metals (arsenic, chromium and beryllium), low volatile metals (lead and cadmium), particulate matter, hydrogen chloride, and chlorine gas

*Building 6*: dioxins and furans, semi-volatile metals (arsenic, chromium and beryllium), low volatile metals (lead and cadmium), particulate matter, hexachloroethane, naphthalene, total hydrocarbons, hydrogen chloride, and chlorine gas

At a minimum, these compounds will be the targeted stack gas COPCs evaluated in the SLERA.

As with all combustion sources, there are a large number of compounds that potentially could be evaluated in the risk assessment. In addition to the compounds that are fed to the industrial furnaces for destruction, products of incomplete combustion (PICs) must be considered. The HHRAP (USEPA, 2005a) has developed a six-step approach for evaluating potential facility emissions to ensure that all reasonable possibilities are considered in the identification of potential COPCs. One of these steps refers to addition of constituents as COPCs based on the availability of human health toxicity data, and therefore is not germane to ecological risk evaluation. The method for identifying COPCs for inclusion in the SLERA will consider the five remaining steps:

1) Evaluate analytical data from the CPT to determine which compounds are detected in the stack emissions.
2) Evaluate all wastes that the unit will be permitted to burn. Retain for evaluation any non-detect compound present in the waste.
3) Retain for evaluation any non-detect compound with a high potential to be emitted as a Product of Incomplete Combustion (PIC).
4) Retain for evaluation those compounds that (1) are a concern due to site-specific factors, and (2) may be emitted by the combustor.
5) Evaluate the tentatively identified compound (TIC) peaks obtained during gas chromatography (GC) analysis, to determine whether any of the TICs have toxicities similar to the detected compounds.

GD-OTS MS proposes to identify a list of COPCs emitted from Buildings 1, 3, and 6 in accordance with the HHRAP guidance (USEPA 2005a) and submit the proposed list to the USEPA and the MDNR as an interim deliverable prior to running the IRAP-h View model.

### 2.4 ESTIMATING COPC CONCENTRATIONS FOR NON-DETECTS

Section 2.3 (above) outlines a protocol for developing a list of COPCs for the emission associated with Buildings 1, 3, and 6. Steps 2 and 3 of the protocol recommend the retention of non-detected compounds that are expected due to the composition of the waste stream or compounds that have a high potential to be emitted as a PIC. The HHRAP guidance (USEPA 2005a) recommends the following protocols for managing non-detects for constituents that might be COPCs:

1) Use the Method Detection Limit (MDL)-derived reliable Detection Limit (RDL) to quantify non-detects for COPCs analyzed with non-isotope dilution methods; and
2) Use the method-defined Estimated Detection Limit (EDL) to quantify non-detects for COPCs analyzed with isotope dilution methods.

The interim deliverable described throughout this section will also include a discussion of the methodology used to manage non-detects associated with the CPT for Buildings 1, 3, and 6.

## 3. AIR DISPERSION AND DEPOSITION MODELING

Air dispersion and deposition modeling will be conducted to estimate unitized air impacts and deposition rates for the emissions from Buildings 1, 3 and 6 to support the human health and ecological risk assessments. The modeling will be conducted with USEPA's current guideline model, AERMOD Version 12060 (USEPA Guideline on Air Quality Models as incorporated in Appendix W of 40 CFR Part 51).

The AERMOD modeling analysis will be conducted in accordance with USEPA recommendations for conducting modeling in support of the risk assessments as outlined in the HHRAP guidance (USEPA 2005a). The modeling procedures and input requirements are discussed in this section.

### 3.1 SOURCE DATA

In addition to the emissions data (discussed in Section 2.0), stack parameters for Buildings 1, 3 and 6 will be required for the modeling. The following stack data will be compiled and summarized in the HHRA and SLERA:

- Stack height;
- Stack diameter;
- Exhaust velocity; and
- Exhaust temperature

The modeling will be performed with a unit (1 gram/second; g/sec) emission rate. COPC-specific air concentrations and deposition rates will be determined within IRAP-h View by multiplying the normalized impacts by the emissions expressed in g/sec.

In addition to the physical stack parameters and exhaust stack parameters, particle size distribution data on stack emission are required to perform deposition modeling. If unit-specific particle size distribution data are not available, the aerodynamic size distribution of emitted particulates will be based on published data for units that are expected to have similar particle size distribution to the sources in this analysis. If the available data is not representative of the emissions expected from Buildings 1, 3, and 6, the AERMOD "Method 2" may be utilized in the model in lieu of "Method 1." Method 2 does not require a detailed particle size distribution, but rather, relies on the assumption that a small fraction (less than 10 % of the mass) is particles with a diameter of 10 micrometers or larger.

In accordance with the HHRAP, two different particle size distributions will be modeled. The distribution of particle mass will be used to represent all metals except arsenic, lead, and mercury when present. Semi-volatile organic species and low boiling point metals (such as arsenic and lead) that tend to vaporize during combustion and condense on the surface of emitted fly-ash are represented by a surface area-weighted size distribution ("particle-bound"). This approach tends to produce more realistic (and often lower) deposition rates of these materials in the immediate vicinity of the source. The proposed particle distributions and accompanying discussion of their development will be included in the risk assessment reports.

In addition to the source data described above, building data are also required for stacks potentially subject to aerodynamic building downwash. The Receptor Location Report (USEPA 2006a) states that "Evaluation of the air modeling output indicates that building downwash is not significant." However, the statement is based on the air dispersion modeling conducted for the 1995 HHRA. Therefore, the potential for downwash will be reevaluated.

The analysis used to evaluate the potential for building downwash is referred to as a "Good Engineering Practice" (GEP) stack height analysis. The GEP stack height analysis is conducted using the USEPA's Building Profile Input Processor (BPIP) program. Building dimensions required for input to AERMOD are developed by BPIP for stacks less than the GEP height. To conduct the GEP analysis, a facility plot plan showing the locations of Buildings 1, 3, and 6 relative to existing and/or proposed buildings and structures at the facility is required. The building and structural elevations will also be compiled and documented.

## 3.2 METEOROLOGICAL DATA

Five years of meteorological data from the nearest representative National Weather Service station are required to conduct the dispersion and deposition modeling. Five years of surface meteorological and precipitation data from Springfield, Missouri and five years of concurrent upper air data from Monet, Missouri will be compiled and processed for input to AERMOD.

AERMET, USEPA's meteorological pre-processor for AERMOD, will be used to consolidate the hourly surface and precipitation data and upper air data. The five years of processed meteorological data will be combined into a single meteorological data file for input to AERMOD to compute five-year averages of air concentrations and deposition rates as recommended by the HHRAP. In addition to the raw meteorological data, site characteristics including surface roughness, albedo and Bowen ratio will be identified using USEPA's AERSURFACE program. AERSURFACE incorporates the current USEPA guidance for calculating surface roughness; albedo and Bowen ratio as contained in the USEPA AERMOD Implementation Guide (USEPA 2009). Surface roughness will be calculated based on land use 1-km upwind from the meteorological tower.

## 3.3 APPLICATION OF AERMOD

AERMOD will be applied to determine maximum short-term air concentrations and long-term averages (based on five years modeled) of air concentrations as well as wet, dry, and total deposition for vapors, particles, and particle-bound chemicals. As such the following iterations will be conducted with AERMOD to obtain the modeled air concentrations and deposition rates required for input into IRAP-h View:

1) Wet and dry deposition of particles, based on mass-weighted particle distribution including plume depletion;

2) Wet and dry deposition of particles, based on area-weighted particle size distribution including plume depletion; and

3) Wet and dry deposition of vaporous gases with plume depletion.

The risk assessment study areas and modeling domain will include an area within 10 km of the facility. This domain will be sufficient to resolve the maximum modeled impacts from Buildings 1, 3 and 6 and will cover the local sections of nearby water bodies and watersheds.

Land use within 3-km of the facility will be classified in accordance with the USEPA recommended method based on information contained on U.S. Geological Survey (USGS) maps and satellite photography. This classification is used to determine whether AERMOD will be run in a rural or urban mode.

A comprehensive Cartesian receptor grid will be developed for the dispersion and deposition modeling per the HHRAP guidance. Specifically, the Cartesian receptor grid will consist of 100 meter (m) spaced receptors from the fence-line out to 3-km and 500-m spaced receptors beyond 3 km out to 10 km. In addition, the facility fenceline will be delineated by discrete receptors placed at 50 m intervals along the property boundary line. Alternatively, pending USEPA's approval, the QD (Quantity Distance) Safety Arcs will be used instead of the facility fenceline. Ultimately, the receptor spacing will be adequate to resolve maximum impact areas and impacts at natural resources features such as woodlands, wetlands, streams, and other habitats likely to support ecological populations and communities.

Receptor terrain elevations and receptor information required by AERMOD will be developed though application of the receptor/terrain processor AERMAP. AERMAP will utilize terrain elevations obtained from Digital Elevation Model (DEM) data (30-m resolution) acquired from USGS.

Modeling results will be presented in the final risk assessment reports as isopleths of unitized concentrations and deposition rates with coordinated tables showing the relative exposure impacts of Buildings 1, 3, and 6 at selected locations of importance for the risk assessments.

All model input and output files will be provided to the MDNR and USEPA Region 7 on CD-ROM, including model output in a format ready for input into the IRAP-h View risk modeling program.

## 4. SCREENING LEVEL PROBLEM FORMULATION

Screening level problem formulation is the systematic planning process that identifies the factors that should be addressed in a SLERA. This section presents information regarding the environmental setting and ecological characteristics of the GD-OTS MS facility grounds and surrounding areas. It also includes the elements of the preliminary ecological conceptual site model (CSM), including the assessment endpoints, the ecological receptors representing the assessment and measurement endpoints, and ecological exposure pathways.

### 4.1 ECOLOGICAL CHARACTERIZATION

Little information is available on the suitability of habitats at and in the vicinity of the GD-OTS MS facility for supporting viable natural ecological communities. The property directly surrounding and within at least 1,000 feet of the GD-OTS MS facility, in all directions, is owned by Expert Management, Inc. (EMI), and was originally used for the manufacturing of commercial explosives. All operations on this property have been discontinued, all facilities have been demolished, and the majority of the land returned to its natural state. Surrounding the EMI property, the land is characterized as agricultural crop land and pasture, light industrial, mixed rangeland, and mixed forest land capable of supporting a variety of terrestrial organisms. Oak and hickory forests are most the common woodland covertypes. There are some small residential areas in the vicinity; however, the majority of the surrounding properties are small to mid-sized farms. Terrestrial land use and covertypes in the vicinity of the GD-OTS MS facility are presented in **Figure 4**.

Watercourses near the GD-OTS MS facility include Center Creek, Grove Creek, some small unnamed tributaries to the creeks, and some small unnamed ponds (reported to be tailing ponds in the Receptor Location Report [USEPA 2006a]), none of which are within 1,000 feet of the GD-OTS MS facility. The Receptor Location Report (USEPA 2006a) indicates that Grove Creek is a shallow, slow-moving creek that runs behind the Atlas Industrial Park. The MDNR identified Grove Creek as supporting a protection of aquatic life (AQL) designated use (MDNR 2010). AQL waters are primarily warm-water systems in which natural water quality and/or habitat conditions prevent the maintenance of naturally-reproducing populations of recreationally-important fish species. The MDNR classifies Center Creek as a cool water fishery (CLF) that is protective of aquatic life. The CLF designation refers to waters in which naturally-occurring water quality and habitat conditions allow the maintenance of a sensitive, high-quality sport fishery (including smallmouth bass and rock bass) and other naturally-reproducing populations of recreationally-important fish species (MDNR 2010). Water quality in much of Center Creek is considered "good," but deteriorates at its confluence with Grove Creek (MDNR 2006).

Wetlands in the vicinity of the GD-OTS MS facility were identified from the U.S. Fish and Wildlife Service National Wetland Inventory's (NWI) on-line Wetlands Mapper program. Wetlands localized around Grove Creek and Center Creek are primarily classified by the NWI as PF01A (**Figure 4**), or palustrine, forested, broad-leaved deciduous wetlands that are temporarily flooded (USFWS 2012). Freshwater emergent wetlands are the second most common local wetland type, and are present primarily along the western edge of Grove Creek.

### 4.2 POTENTIAL ECOLOGICAL EXPOSURE PATHWAYS

A SLERA evaluates available information to identify complete exposure pathways for potential ecological receptors. When facilities such as the GD-OTS MS facility release emissions from their operations, dispersion of COPCs into the ambient air results in deposition onto soil and surface water features. COPCs deposited onto soil may then be transported through stormwater runoff or sheet flow to watercourses, where they may remain in the water column or be further deposited onto sediments. COPCs from stack emissions are available for indirect exposure to ecological receptors through direct contact with soil and sediment. Additionally, the COPCs are potentially available through other secondary indirect pathways of exposure, including ingestion of terrestrial plants, invertebrates, and small mammals, and ingestion of sediment-dwelling invertebrates and fish.

Based on the available information pertaining the GD-OTS MS facility and surrounding areas, the following potentially complete ecological exposure pathways will be evaluated in the SLERA:

- Terrestrial receptor exposure to surface soil (0-1 foot below ground surface [bgs])

- Terrestrial receptor exposure to terrestrial prey items (plants, soil invertebrates, small mammals)
- Aquatic receptor exposure to surface sediment (0-0.5 feet bgs)
- Aquatic receptor exposure to surface water
- Aquatic receptor exposure to aquatic prey items (benthic invertebrates, fish)

Ecological receptors may be exposed to COPCs through the following exposure routes:

- Absorption and root uptake of COPCs in soil by terrestrial plants
- Direct contact with COPCs in soil
- Incidental ingestion of COPCs in soil (e.g., during foraging bouts or during grooming)
- Incidental ingestion of COPCs in sediment (e.g., during foraging bouts or during grooming)
- Direct contact with COPCs in sediment
- Direct contact with COPCs in surface water
- Ingestion of potentially impacted soil-associated biota
- Ingestion of potentially impacted sediment-associated biota

With the exception of direct contact for soil invertebrates, dermal contact and inhalation are considered minor pathways for wildlife receptors. Inhalation and dermal absorption pathways were not considered further in this SLERA because they typically have a negligible contribution to the overall exposure for wildlife receptors (Sample et al. 1997; USEPA 2000a). This approach is consistent with USEPA's *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities – Peer Review Draft* (USEPA 1999). In addition, ingestion of surface water typically only contributes a negligible quantity to the total risk incurred by wildlife; hence, this pathway also will not be evaluated in the SLERA.

### 4.3 POTENTIAL RECEPTORS OF CONCERN

Ecological receptors of concern for the site were selected to represent aquatic, semi-aquatic, and terrestrial communities and species in the major consumer trophic levels. As described in Section 4.1, the forested areas and creeks in proximity of the GD OTS MS facility potentially support a variety of flora and fauna. As such, ecological receptors selected for the SLERA are terrestrial plants, invertebrates, fish, and certain guilds of birds and mammals that are likely to occur in suitable ecological habitat near the facility and also have the potential for direct and/or indirect contact with emissions-related COPCs in soil, sediment, and surface water.

Terrestrial community level receptors selected to evaluate direct contact exposure to COPCs in soil include:

- Plant communities; and
- Soil invertebrate communities.

Terrestrial wildlife receptors selected to characterize food chain exposure to COPCs in soil include:

- Omnivorous bird: American robin (Turdus migratorius);
- Carnivorous bird: Red-tailed hawk (Buteo jamaicensis); and
- Invertivorous mammal: Short-tailed shrew (Blarina brevicauda).

Aquatic community level receptors selected to evaluate direct contact exposure to COPCs in sediment and surface water include:

- Benthic invertebrate communities; and
- Fish and other water-column biota communities.

Semi-aquatic wildlife receptors selected to characterize food chain exposure to COPCs in sediment and surface water include:

- Carnivorous bird: Great blue heron (*Ardea herodias*); and
- Omnivorous mammal: Raccoon (*Procyon lotor*)

Threatened and endangered species will also be considered for the SLERA. Prior to development of the SLERA, the Missouri Department of Natural Resources (MDNR) and the United States Fish and Wildlife Service (USFWS) will be contacted to provide records of any State or Federal listed plant or animal species occurring in the vicinity of the GD-OTS MS facility. Responses from both agencies will be used as the basis for including or excluding listed species in the ecological CSM.

**Figure 5** presents the preliminary ecological CSM for the GD-OTS MS facility, and describes the known linkages between sources of COPCs (emissions from Buildings 1, 3, and 6) and potential ecological receptors.

### 4.4 ASSESSMENT AND MEASUREMENT ENDPOINTS

Assessment endpoints are explicit statements of ecological resources or entities, and attributes of those entities that are important to protect (USEPA 1998). The assessment endpoints selected represent the protection of populations and communities because the loss of one or a few individuals is unlikely to compromise the healthy function of an ecological community unless the individual is threatened or endangered and is regularly present in areas known or suspected to be impacted (USEPA 1992). Measurement endpoints represent quantifiable ecological characteristics that can be measured, interpreted, and related to ecological resources selected as assessment endpoints (USEPA 1997). The following assessment and measurement endpoints were selected to evaluate exposure to community level and wildlife receptors potentially using the resources in habitable areas adjacent to the facility.

<u>Terrestrial Plant Community</u>:

- *Assessment Endpoint:* Viability and function of the terrestrial plant community
- *Measurement Endpoint:* Comparison of modeled maximum concentrations of COPCs in soil to concentrations representing no-observable-effect-concentrations (NOECs) for plants

<u>Soil Invertebrate Community</u>:

- *Assessment Endpoint: Viability and function of the soil invertebrate community*
- *Measurement Endpoint: Comparison of modeled maximum concentrations of COPCs in soil to concentrations representing NOECs for soil invertebrates*

<u>Benthic Invertebrate Community</u>:

- *Assessment Endpoint: Viability and function of the benthic invertebrate community*
- *Measurement Endpoint: Comparison of modeled maximum concentrations of COPCs in sediment to concentrations representing NOECs for benthic invertebrates*

<u>Fish/Water-Column Biota Community</u>:

- *Assessment Endpoint: Viability and function of the fish and pelagic invertebrate community*
- *Measurement Endpoint: Comparison of modeled maximum concentrations of COPCs in surface water to concentrations representing NOECs for fish and other water-column biota*

<u>Terrestrial Omnivorous Bird Populations</u>:

- *Assessment Endpoint: Viability and function of terrestrial omnivorous bird populations*
- *Measurement Endpoint: Comparison of average daily doses (ADDs) of COPCs for the American robin to COPC-specific toxicity reference values (TRVs).*

Terrestrial Carnivorous Bird Populations:

- *Assessment Endpoint: Viability and function of terrestrial carnivorous bird populations*
- *Measurement Endpoint: Comparison of ADDs of COPCs for the red-tailed hawk to COPC-specific TRVs.*

Terrestrial Invertivorous Mammal Populations:

- *Assessment Endpoint: Viability and function of terrestrial invertivorous mammal populations*
- *Measurement Endpoint: Comparison of ADDs of COPCs for the short-tailed shrew to COPC-specific TRVs.*

Semi-Aquatic Carnivorous Bird Populations:

- *Assessment Endpoint: Viability and function of semi-aquatic carnivorous bird populations*
- *Measurement Endpoint: Comparison of ADDs of COPCs for the great blue heron to COPC-specific TRVs.*

Semi-Aquatic Omnivorous Mammal Populations:

- *Assessment Endpoint: Viability and function of semi-aquatic omnivorous mammal populations*
- *Measurement Endpoint: Comparison of ADDs of COPCs for the raccoon to COPC-specific TRVs.*

## 5. SCREENING LEVEL EXPOSURE ASSESSMENT

The exposure assessment phase of the SLERA is based on the preliminary ecological CSM and includes an assessment of receptor exposures and toxicological effects. Information on the effects of the chemical stressors are summarized and related to the assessment endpoints. The goal of the exposure assessment is to predict the magnitude of possible ecological exposure to COPCs in emissions from the facility through potential exposure pathways. In the combustion risk assessment process, the air dispersion and deposition modeling, discussed in Section 3.0, provide the foundation for all other environmental concentration modeling efforts. The final air dispersion and deposition modeling results will be entered into the Lakes Environmental Software IRAP-h View model, which will provide the basis for estimating exposure concentrations in each ecologically relevant exposure medium (*i.e.*, soil, sediment, and surface water).

Screening-level exposure estimations consider very conservative exposure scenarios. Conservative assumptions will be used to estimate potential ecological exposure to COPCs for all relevant pathways. While the Site reconnaissance conducted for the Receptor Location Report (USEPA 2006a) evaluated land uses within a 10-km radius of the GD-OTS MS facility, the characterization of the exposure settings focused on a 3-km radius from the facility because the highest concentrations COPCs will be deposited in this area. As such, to maintain the conservative nature of the screening level evaluation, the SLERA will focus on potential ecological exposure within a 3-km radius of the facility.

USEPA ecological risk assessment guidance (USEPA 1997; 1999) places emphasis on evaluating the chronic effects of constituents on the well-being of ecological populations and communities. Assessing short-term exposures and risks is not standard ecological risk assessment practice. As such, only chronic ecological exposure scenarios will be evaluated in the SLERA for the GD-OTS MS facility.

### 5.1 DIRECT CONTACT EXPOSURE

Potential direct contact risk to community level receptors resulting from GD-OTS MS facility stack emissions will be assessed through comparisons of estimated maximum concentrations of COPCs in surface soil, sediment, and surface water to medium-specific no-effect concentrations (*i.e.*, NOECs). The NOECs used to derive screening level risks for community level receptors are presented in Sections 6-1 through 6-4.

### 5.2 FOOD CHAIN EXPOSURE

Simplified exposure models will be developed to calculate average daily doses (ADDs) of COPCs that avian and mammalian wildlife receptors experience through direct and indirect exposure to soil and sediment. ADDs for wildlife receptors will be calculated using: (1) estimated maximum concentrations of bioaccumulative COPCs in soil, sediment, and prey, and (2) receptor-specific exposure parameters and dose rate model assumptions. Calculated ADDs will be compared to wildlife toxicity reference values (TRVs) representing no observable adverse effects levels (NOAELs) and low observable adverse effects levels (LOAELs) to evaluate the potential for adverse ecological effects from exposure to bioaccumulative COPCs. The following sections describe the methodologies for calculating ADDs, including the derivation of receptor-specific exposure parameters, bioaccumulation factors (BAFs), biota-sediment accumulation factors (BSAFs), and area use factors (AUFs).

The wildlife food chain exposure evaluation will be conducted for all COPCs known or suspected to bioaccumulate in biota tissue. Constituents considered bioaccumulative are indicated in USEPA's *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment: Status and Needs* (USEPA 2000b) and USEPA Region 3 Biological Technical Assistance Group's (BTAG) *Freshwater Sediment Screening Benchmark Table* (USEPA 2006b).

#### 5.2.1 Terrestrial Food Chain Screening

For the terrestrial food chain pathway, estimated maximum soil concentrations of bioaccumulative COPCs will be compared avian and mammalian soil screening benchmarks to determine if they should be retained for wildlife food-chain calculations and to focus the wildlife exposure evaluation on constituents likely to drive food chain risk.

The following benchmarks were used, in order of preference:

- USEPA Ecological Soil Screening Levels (Eco-SSLs) for mammals (USEPA 2010)
- USEPA Region 5 Ecological Screening Levels (ESLs) for soil (USEPA 2003a)

Eco-SSLs are ecological screening levels that represent soil concentrations that are protective of several types of biological organisms, including birds and mammals. The Eco-SSL derivation process was a collaborative effort of a multi-stakeholder workgroup consisting of federal, state, consulting, industry and academic participants led by the USEPA's Office of Emergency and Remedial Response. Eco-SSLs and soil ESLs were selected for the food chain screening assessment because they incorporate the concept of bioaccumulation into the development of protective soil concentrations for wildlife.

Bioaccumulative COPCs with estimated maximum soil concentrations exceeding the Eco-SSLs or ESLs will be considered food chain COPCs, and evaluated for trophic transfer as described in the following sections. COPCs with maximum soil concentrations less than the Eco-SSLs or ESLs will be eliminated from further evaluation of the trophic transfer pathway. COPCs considered bioaccumulative by USEPA and lacking Eco-SSLs or ESLs will be retained for further evaluation as a conservative measure.

### 5.2.2 Modeling Approach

The wildlife food chain pathway will be evaluated by considering the trophic transfer of COPCs from Site soil, sediment, or surface water through the food chain to the selected ecological receptors. The simplified dose model considers the primary routes of exposure to wildlife receptors: the direct ingestion of prey and the incidental ingestion of substrate (*e.g.*, soil or sediment). Estimated chemical concentrations in prey and food items are expressed as a function of chemical concentrations in soil and sediment using BAFs for terrestrial prey items and BSAFs for aquatic prey items. Other important parameters in the model include receptor body weight, food ingestion rates, and AUF.

The total dose ($ADD_{total}$) experienced by each receptor is the sum of the doses obtained from the primary routes of exposure, the direct ingestion of prey and the incidental ingestion of substrate which, depending on the receptor, is either soil or sediment:

$$ADD_{total} = ADD_{diet} + ADD_{substrate}$$

As described in Section 4.2, water ingestion typically contributes only a negligible amount to the overall dose to wildlife receptors; therefore, this pathway will not be included in the food chain evaluation to permit the evaluation to focus on the more important dietary pathways.

In the model, the dose from each route of exposure is calculated individually as follows:

**Dietary Dose:**

$$ADD_{diet} = \frac{IR_{food} \times \sum (C_{food} \times DF_i) \times AUF}{BW}$$

where:

| | |
|---|---|
| $ADD_{diet}$ | = Dose of COPC obtained from the diet (mg COPC/kg receptor body weight-day) |
| $IR_{food}$ | = Ingestion rate of food (kg food ingested per day, dry weight) |
| $C_{food}$ | = Concentration of COPCs in food item *i* (mg COPC/kg food item, dry weight) |
| $DF_i$ | = Dietary fraction of food item *i* (proportion of food type in the diet) |
| AUF | = Area use factor |
| BW | = Body weight of the receptor, wet weight (kg) |

**Substrate Dose:**

$$ADD_{substrate} = \frac{IR_{substrate} \times C_{substrate} \times AUF}{BW}$$

where:

$ADD_{substrate}$ = Dose of COPC obtained from the incidental ingestion of substrate (mg COPC/kg receptor body weight-day)
$IR_{substrate}$ = Incidental ingestion rate of substrate (kg substrate ingested per day, dry weight)
$C_{substrate}$ = COPC concentration in substrate (mg COPC/kg substrate, dry weight)
AUF = Area use factor
BW = Body weight of the receptor, wet weight (kg)

The dose of COPCs from diet and incidental substrate ingestion for each receptor is modeled using dry weight parameters to avoid introducing unnecessary uncertainty into the model by converting parameters from dry weight to wet weight based on approximate moisture contents of dietary items. Food ingestion rates, substrate (media) ingestion rates, and substrate-to-biota accumulation rates are expressed on a dry weight basis.

In the SLERA, receptor ADDs will be calculated based on two highly conservative exposure assumptions, as specified by USEPA ecological risk assessment guidance (USEPA 1997; 1999):

- Receptors consume and assimilate the maximum concentrations of COPCs in prey and media; and
- Receptors forage 100% of the time in the area of concern or area of impact.

This approach will provide a "worst case" dose estimate that is not representative of actual exposure, but that is conservative and appropriate for a screening level evaluation (*i.e.*, SLERA).

### 5.2.3 Receptor-Specific Exposure Parameters

Each wildlife receptor reflects an assessment endpoint, which considers trophic category and particular feeding behaviors (e.g., insect-eating birds versus fish-eating birds) that represent different types of exposure to COPCs. Consequently, the species chosen for evaluation is used as a surrogate for a given group of ecological receptors and, thus, may represent several similarly exposed species in the area.

Exposure parameters used to determine the ADD for each receptor include body weight (kg, wet weight), food ingestion rate (kg dry weight/day), incidental substrate (soil or sediment) ingestion rate (kg dry weight/day), dietary composition, and area use. Typical body weights for receptors were obtained from various literature sources for use in the models. Food ingestion rates ($IR_{food}$) for selected wildlife receptors are based on allometric regression analyses of feeding rates versus body mass for over 170 species of mammals and birds (Nagy 2001), as follows:

- American robin (omnivore) - $IR_{food}$= 0.67(g BW)$^{0.627}$
- Great blue heron (carnivore) - $IR_{food}$= 0.849(g BW)$^{0.663}$
- Red-tailed hawk (carnivore) - $IR_{food}$= 0.849(g BW)$^{0.663}$
- Raccoon (omnivore) - $IR_{food}$= 0.432(g BW)$^{0.678}$
- Short-tailed shrew (invertivore) - $IR_{food}$= 0.373(g BW)$^{0.622}$

Incidental substrate ingestion rates will be obtained from Beyer et al. (1994), Sample and Suter (1994), or USEPA (1993). Dietary composition and area use information (*i.e.*, typical home range) will be obtained from literature sources, including USEPA (1993), Sample and Suter (1994), and other literature sources. Exposure information for each wildlife receptor species is summarized in **Table 1**.

### 5.2.4 Bioaccumulation/Biota Sediment Accumulation Factors

Terrestrial and aquatic bioaccumulation factors provide quantitative indicators of the tendency for a chemical to partition into biological organisms relative to the concentrations present in soil and sediment, respectively. Site-specific measurements of tissue concentrations are the best data to reduce uncertainty in estimating exposure point concentrations in dietary components. However, the collection of tissue for all dietary components is not practical in most ecological risk assessments. Therefore, typically BAFs and BSAFs are utilized in the risk evaluation process to address terrestrial and aquatic bioaccumulation. BAFs and BSAFs represent observed or predicted ratios between chemical concentrations in terrestrial prey and soil, and aquatic prey and sediment, respectively. The following sections describe the approaches used to assess constituent uptake in prey items.

***Terrestrial Bioaccumulation Factors***

Concentrations of COPCs in dietary items for terrestrial wildlife receptors will be estimated using terrestrial BAFs. BAFs provide quantitative indicators of the tendency for a chemical to partition into terrestrial prey organisms relative to the concentrations present in soil. BAFs used to calculate concentrations of chemicals in terrestrial food items such as plants, soil invertebrates, and small mammals, will be derived from the literature as indicated below.

Terrestrial Plants: The concentrations of select metals and organics in terrestrial vegetation will be estimated consistent with EPA Eco-SSL guidance (USEPA 2005b) using the recommended applications of single variable plant uptake regression models developed by Efroymson et al. (2001) or USEPA (2007). Point estimate uptake values from Bechtel-Jacobs (1998a) or Baes et al. (1984) will be applied for metals lacking a statistically significant linear relationship for plant uptake.

Soil Invertebrates: The concentrations of select metals in soil invertebrates will be estimated consistent with EPA Eco-SSL guidance (USEPA 2005b) using the recommended applications of earthworm bioaccumulation regression models developed by Sample et al. (1999). Concentrations of some metals will be based on point estimate soil invertebrate BAFs reported in Sample et al. (1998a; 1999). Concentrations of organic compounds in soil invertebrates will be estimated using median uptake factors (for polycyclic aromatic hydrocarbons [PAHs]) or regression-derived BAFs (USEPA 2007).

Small Mammals: Concentrations of select metals in small mammals will be estimated consistent with EPA Eco-SSL guidance (USEPA 2005b) using the recommended applications of small mammal bioaccumulation regression models developed by Sample et al. (1998b) and point estimate BAFs from Baes et al. (1984). PAH compounds ingested by mammals are metabolized rapidly and excreted (USEPA 2007). Consequently, bioaccumulation of PAHs in small mammals is anticipated to be negligible. Limited data are available to estimate bioaccumulation of many organic compounds from soil into small mammals. Concentrations of other organic compounds in small mammal tissues will be estimated based on bioaccumulation of organic compounds into beef (Travis and Arms 1988).

***Aquatic Biota-Sediment Accumulation Factors***

Concentrations in dietary items for terrestrial receptors will be estimated using aquatic BSAFs. BSAFs provide quantitative indicators of the tendency for a chemical to partition into organisms relative to the concentrations present in sediment. BSAFs used to calculate exposure point concentrations (EPCs) of chemicals in benthic invertebrates and fish will be derived from published information, as indicated below.

Benthic Invertebrates: The concentrations of metals in benthic invertebrate tissues will be estimated based on regression models developed by ORNL (Bechtel-Jacobs 1998b) or from BSAFs obtained from the literature. Concentrations of organic compounds in benthic invertebrates will be estimated using literature-derived normalized BSAFs, which are calculated as the ratio of lipid-normalized tissue concentrations to organic carbon normalized sediment concentrations. Normalized BSAFs for organics will be estimated as a function of the octanol-water partition coefficient ($K_{ow}$) (DiToro and McGrath 2000):

$$BSAF_{norm} = K_{ow}^{-0.38}$$

Site-specific BSAFs for organic compounds will be calculated from normalized BSAFs based on sediment organic carbon and the average lipid concentration estimated for benthic invertebrates. Site-specific BSAFs will be calculated as follows:

$$BSAF = BSAF_{norm} \times f_{lipid} \times f_{oc}$$

where:

| | |
|---|---|
| $BSAF_{norm}$ | = Normalized BSAF for each compound (kg sediment organic carbon/kg lipid); |
| $f_{lipid}$ | = Fraction of lipids (0.065 or 6.5%, dry weight); and |
| $f_{oc}$ | = Average fraction of sediment organic carbon on a dry weight basis (assumed to be 1%). |

Because Site-specific organic carbon content of sediments in Grove Creek and Center Creek is likely unavailable, a default organic carbon (OC) content of 1% will be assumed. An OC concentration of 1% is commonly used as a default value when site-specific information is unavailable (USEPA, undated). The fraction of lipids is based on the average lipid content of freshwater worms reported in the United States Army Corps of Engineers' (USACE's) BSAF Database (USACE 2012).

Fish: Although direct uptake of COPCs by many fish species is closely associated with surface water, fish may forage on sediment-dwelling organisms. Therefore, to provide conservatism in the SLERA, uptake will be derived conservatively from calculated COPC concentrations in sediment. The concentrations of metals in fish tissue will be estimated based on BSAFs reported by Song and Breslin (1999) or from other literature sources of bioaccumulation. Concentrations of organic compounds in fish will be estimated using the methodology described in DiToro and McGrath (2000), as presented above for invertebrates. The fraction of lipids in fish is assumed to be 8%, based on the average dry weight value reported for bottom-feeding fish in the USACE's BSAF Database (USACE 2012).

### 5.4.5 Area Use Factor

An AUF accounts for the proportion of time that an organism spends in an area of concern during the time period of possible exposure. Generally, this factor is calculated as the ratio of the size of the exposure area to the area of the home range of each receptor, but may also include considerations of temporal use of the exposure area (*i.e.*, seasonality). The use of an AUF in estimating ecological risk provides a more realistic estimate of exposure and reduces the overall uncertainty of the risk assessment. However, an AUF of 1.0 (100 percent) will be used to calculate the ADD for each wildlife receptor in order to provide very conservative exposure estimates for use in the SLERA.

## 6. SCREENING LEVEL ECOLOGICAL EFFECTS CHARACTERIZATION

The ecological effects characterization is a qualitative and quantitative description of the relationship between chemical concentrations or doses and the nature of possible effects elicited in potentially exposed receptor populations or communities. This step consists of evaluating available toxicity or other effects information that can be used to relate the: 1) modeled exposure concentration in habitable terrestrial and aquatic areas impacted by facility emissions to no-effect concentrations (NOECs) for community-level ecological receptors (e.g., invertebrate, fish, and plant communities), and 2) calculated ADDs in the terrestrial and aquatic habitat areas to no-effect and lowest-effect toxicity reference values (TRVs) for wildlife receptors (*e.g.*, birds, mammals). Stressor-response data used to evaluate ecological risks resulting from chemical exposures will be derived from peer-reviewed values from a compendium of studies (e.g., USEPA's Eco-SSLs) or from single-study based literature values.

The following sections describe the characterization of effects for the community-level and wildlife receptors that may inhabit the areas impacted by facility emissions. A hierarchical selection process will be used to evaluate direct contact risks for each ecological exposure medium in the SLERA, as described in the following sections. Constituents with maximum concentrations below ecological screening benchmarks are not considered to pose an unacceptable risk to community-level receptors.

It should be noted that there are significant limitation to the use of media-specific no-effect screening benchmarks (*i.e.*, NOECs) used to identify COPCs for community receptors (e.g., soil invertebrates, benthic invertebrates, fish/aquatic biota, terrestrial plants). These criteria are conservative values and generally are not used to determine the direct contact risk. Additionally, they provide little information on the actual bioavailability or toxicity of a particular constituent, and assume a direct causal relationship between constituent concentrations and observed effects. Consequently, the resulting screening level risk estimates generated through the application of these NOECs are useful for identifying COPCs, but are likely to represent gross overestimations of actual risk.

### 6.1 SOIL INVERTEBRATES

The potential effects of stack emissions from the GD-OTS MS facility on the terrestrial invertebrate community will be assessed through comparisons of modeled maximum concentrations of COPCs in surface soil to soil invertebrate NOECs. Modeled constituent concentrations in surface soil will be compared to values presented in the following sources:

- USEPA Ecological Soil Screening Levels (Eco-SSLs) for soil invertebrates (USEPA 2010);
- Oak Ridge National Laboratory (ORNL) values – lowest value reported for earthworms and microorganisms (Efroymson et al. 1997a); or
- USEPA Region 5 ESLs for soil (USEPA 2003)

The sources above will be applied in a hierarchical manner. In other words, if no Eco-SSL is available for comparison, then an ORNL value will be used. If no Eco-SSL or ORNL value is available, then an ESL value will be used.

Single-study based NOEC values from the literature will be applied if no Eco-SSL, ORNL, or ESL is available. Note that PAH compounds in soil will be evaluated as "low molecular weight" (LMW) PAHs and "high molecular weight" (HMW) PAHs, per USEPA (Eco-SSL) guidance (USEPA 2007). The Eco-SSLs for each of these two groups will be used as the PAH ecotoxicity values. LMW PAHs include acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. HMW PAHs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene.

## 6.2 BENTHIC INVERTEBRATES

Comparisons of modeled maximum sediment concentrations of COPCs to sediment NOECs will be the line of evidence used for evaluating screening level risks and exposures to benthic invertebrates in Center Creek and Grove Creek. Sediment NOECs are based on bulk sediment (not sediment pore water), and represent conservative screening benchmarks typically used to identify COPCs in sediment.

No-effect direct contact benchmarks for sediment were identified from the following sources:

- Consensus-based sediment quality guidelines (SQG) for freshwater ecosystems (MacDonald et al. 2000)
- USEPA Region 5 ESLs for sediment (USEPA, 2003a)
- USEPA Region 3 BTAG freshwater sediment benchmarks (USEPA 2006b)

The sources above will be applied in a hierarchical manner. In other words, if no SQG is available for comparison, then an ESL value will be used. If no SQG or ESL value is available, then a USEPA Region 3 BTAG value will be used.

Consistent with the derivation of the consensus-based SQG for total PAHs (tPAHs), the screening value for tPAHs was based on the sum of the concentrations of 16 PAH compounds: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene.

## 6.3 FISH/AQUATIC BIOTA

The potential effects to fish and water-column biota inhabiting Grove Creek and Center Creek from exposure to stack emission COPCs will be assessed through comparisons of modeled maximum concentrations of COPCs in surface water to chronic surface water benchmarks or promulgated criteria established to be protective of the vast majority of freshwater organisms.

To evaluate direct contact risks in surface water, modeled maximum constituent concentrations in Grove Creek and Center Creek surface water will be compared to the benchmarks/criteria presented in the following sources:

- Missouri Water Quality Criteria for Designated Uses – protection of aquatic life (AQL) chronic criteria (MDNR 2010);
- National Recommended Water Quality Criteria (NRWQC) for aquatic life (USEPA 2012);
- Tier II freshwater secondary chronic value (SCV) (Suter and Tsao (1996);
- Lowest chronic values (LCV) - lowest of chronic benchmarks for fish, daphnids, non-daphnid invertebrates, and aquatic plants (Suter and Tsao 1996);
- USEPA Region 5 ESLs for water (USEPA 2003); or
- USEPA Region 3 BTAG freshwater screening benchmarks (USEPA 2006c)

The sources above will be applied in a hierarchical manner. In other words, if no Missouri criterion is available for comparison, then a NRWQC will be used. If no Missouri criterion or NRWQC is available, then a Teir II SCV will be used, and so on.

It should be noted that chronic ecological surface water criteria for some metals (cadmium, chromium, copper, lead, nickel, and zinc) are hardness-dependent. The SLERA will assume a default hardness value of 100 mg/L in Center Creek and Grove Creek.

### 6.4 TERRESTRIAL PLANTS

Estimated maximum COPC concentrations in surface soil (0-1 foot) will be compared to values presented in the following sources to evaluate direct contact exposure of terrestrial plants:

- USEPA Eco-SSLs (USEPA 2010) for plants; or
- ORNL values for plants (Efroymson et al. 1997b)

The sources above will be applied in a hierarchical manner. That is, if no Eco-SSL is available for comparison, then an ORNL will be used.

As described in Section 6.1, PAHs in soil will be evaluated as LMW PAHs and HMW PAHs, per USEPA (Eco-SSL) guidance. The Eco-SSLs for each of these two groups will be used as the screening ecotoxicity values.

### 6.5 WILDLIFE

Wildlife dose-response relationships for COPCs are used to derive TRVs for wildlife receptors, which are defined as a daily ingested amount (mg/kg-BW/day) associated with a specified effect in a specific receptor. Wildlife TRVs are derived from empirical studies of animal effects from chemical stressors. NOAELs are lower-bound levels at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects (*e.g.*, impacts on growth, reproduction, and survival) between the exposed population and an appropriate control population. These values tend to be conservative and, in many cases, underestimate the actual threshold dose at which no adverse effect is observed. LOAELs are the lowest level of a stressor evaluated in a toxicity test or biological field survey that has a statistically significant adverse effect on the exposed organisms compared with unexposed organisms in a control or at a reference site (USEPA 1997). Although comparison to NOAELs will be used to identify if additional evaluation of impacts to wildlife is needed, LOAELs will be used in the SLERA to provide a more realistic evaluation of the potential for adverse ecological effects stemming from wildlife exposure to COPCs.

Avian and mammalian TRVs derived for COPCs provide a measurable means of comparing ecological receptor exposure to laboratory-derived toxicity information for the wildlife food chain ingestion pathway. For the SLERA, preference will be given to Eco-SSL values developed for mammals and birds (USEPA 2010) to evaluate the potential for adverse effects from exposure to COPCs. The USEPA derived the Eco-SSLs from a compendium of peer-reviewed wildlife dose studies, from which NOAELs and or LOAELs are reported. The Eco-SSL is calculated as the geometric mean of the NOAELs for growth and reproduction. If the resulting geometric mean NOAEL is higher than the lowest bounded LOAEL for growth, reproduction, and survival, then the Eco-SSL is the highest bounded NOAEL lower than the lowest bounded LOAEL. The LOAEL-based TRVs to be used in the SLERA represent the geometric mean of the LOAELs for growth, reproduction, and survival from the available Eco-SSLs (USEPA 2010). Other sources of wildlife toxicity effects levels include NOAELs and LOAELs from single studies of chemical effects on chronic endpoints.

### 6.5 SPECIAL CONSIDERATIONS

#### 6.5.1 Dioxin/Furans

Although there are hundreds of dioxin and furan compounds, those compounds for which potential ecological impacts can be quantitatively evaluated are chlorinated dioxin congeners which have four chlorine molecules attached in positions 2, 3, 7, and 8 on the central ring structure. Amongst these congeners, ecotoxicity values have been developed only for 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). The other congeners are assigned toxicity equivalence factors (TEFs) that relate their toxicities to that of 2,3,7,8-TCDD (Van den Berg *et al.*, 2006). Atmospheric fate and transport modeling will be carried out for each of the 17 individual dioxin and furan congeners to determine media concentrations for evaluating direct contact and food chain exposures. The TEFs will then multiplied by the estimated concentrations of the dioxin congeners and summed to generate a toxic equivalent (TEQ) concentration that will be generated for each ecological exposure scenario, per USEPA methodologies for evaluating ecological effects from dioxin (USEPA 2008).

### 6.5.2 Essential Nutrients

The USEPA (2001) reports that calcium, magnesium, sodium, and potassium function as essential nutrients and do not cause toxicity to ecological organisms. As a result, these nutrients will not be evaluated in the SLERA.

## 7. SCREENING LEVEL RISK CHARACTERIZATION

In the screening level risk characterization step, the potential ecological risks associated with facility emissions from Buildings 1, 3, and 6 will be estimated to identify compounds that may pose an unacceptable risk to ecological receptors. The risk characterization step will combine the results of both the exposure assessment and the dose-response assessment to estimate the incremental risks to ecological receptors. For both the direct contact and wildlife ingestion pathways, potential risk to ecological receptors is characterized in terms of hazard quotients (HQ). The screening level risk is quantified by comparing the exposure concentration or ADD to the NOEC or TRV, as described in the following section.

### 7.1 RISK ESTIMATION

For community-level receptors such as terrestrial plants, soil invertebrates, benthic invertebrates, and fish, screening level risks are calculated as follows:

$$HQ = \frac{\text{Maximum Media Concentration}}{\text{NOEC}}$$

For avian and mammalian wildlife receptors, screening level risks are calculated as follows:

$$HQ = \frac{\text{ADD}}{\text{TRV}}$$

The resulting HQs are used to determine the constituents and exposure pathways that require further evaluation. An HQ less than 1 indicates that the potential for adverse ecological impacts is negligible, and no further assessment is warranted. An HQ greater than 1 does not necessarily imply that adverse ecological effects will occur, only that additional evaluation of ecological risk may be needed (*e.g.*, in a baseline ecological risk assessment [BERA]).

### 7.2 UNCERTAINTY ANALYSIS

Estimation of ecological risks that may result from exposure to constituents in the environment is a complex process. Each assumption used in estimating risks, whether it is the toxicity value for a particular chemical or the value of a parameter in an exposure equation, has a degree of variability and uncertainty associated with it. In each step of the ecological risk assessment process, beginning with the problem formulation and data collection and analysis, and continuing through the exposure assessment, and effects and risk characterization, conservative assumptions are made that are intended to be protective of the environment and to ensure that ecological risks are not underestimated.

The risk and hazard values generated in a SLERA are not precise, deterministic estimates, but conditional estimates controlled by conservative upper-bound assumptions regarding exposure and toxicity. The calculated risk values provide an upper bound of the potential ecological risk value, as opposed to a precise estimate of actual ecological risks. The SLERA uncertainty analysis will provide a thorough discussion of the uncertainties associated with each phase of the ecological risk assessment process for the GD-OTS MS facility and how each of these uncertainties may impact the ecological risk estimates. Potential assumptions and other factors that may be addressed in the uncertainty analysis include, but are not limited to:

- Ecological characterization;
- Data quality;
- COPC bioavailability;
- COPC metabolism;
- Ecotoxicity values;
- Toxicity of COPC mixtures; and
- Characterizing risk based on HQs.

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**Table 1**
**Summary of Exposure Parameters for Wildlife Receptors of Concern**
**General Dynamics OTS Munitions Facility**
**Joplin, Missouri**

| Representative Species | | | Home Range[a] | Home Range Reference | Screening Level Area Use Factor (AUF) | Body Weight (kg wet weight) | Dietary Composition | | | | | Ingestion Rates | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Food | | Substrate | | |
| Common Name | Scientific Name | Food-web classification | | | | | Plant Material | Invertebrates | Fish | Small Mammals | References | kg dry weight/day | Reference | % of Dry Intake | kg dry wt./day | Reference |
| **Avian Receptors** | | | | | | | | | | | | | | | | |
| American robin | *Turdus migratorius* | Avian omnivore | 0.42 ha | Sample and Suter 1994 | 1.0 | 0.077 | 60% | 40% | | | USEPA 1993 | 0.010 | Nagy 2001[b] | 4.2% | 0.0004 | Beyer et al. 1994[f] |
| Great blue heron | *Ardea herodias* | Semi-aquatic piscivore | 4.8 km | Sample and Suter 1994 | 1.0 | 2.39 | | | 100% | | USEPA 1993 | 0.147 | Nagy 2001[c] | 0% | 0 | Sample and Suter 1994 |
| Red-tailed hawk | *Buteo jamaicensis* | Terrestrial carnivore | 857 ha | USEPA 1993 | 1.0 | 1.13 | | | | 100% | USEPA 1993 | 0.090 | Nagy 2001[c] | 5.7% | 0.0051 | USEPA 2007 |
| **Mammalian Receptors** | | | | | | | | | | | | | | | | |
| Raccoon | *Procyon lotor* | Semi-aquatic omnivore | 221 ha | USEPA 1993 | 1.0 | 5.8 | 50% | 50% | | | USEPA 1993 | 0.154 | Nagy 2001[d] | 9.4% | 0.014 | Beyer et al. 1994 |
| Short-tailed shrew | *Blarina brevicauda* | Terrestrial invertivore | 0.39 ha | Sample and Suter 1994 | 1.0 | 0.015 | | 100% | | | USEPA 1993 | 0.002 | Nagy 2001[e] | 3% | 0.00006 | USEPA 2007 |

**Notes:**
a, ha = hectares; km =kilometers
b, Estimated food ingestion rate (kg/day dry weight) for omnivorous birds = $(0.670[\text{Body Weight in kg*1000}]^{0.627})/1000$;
c, Estimated food ingestion rate (kg/day dry weight) for carnivorous birds = $(0.849[\text{Body Weight in kg*1000}]^{0.663})/1000$;
d, Estimated food ingestion rate (kg/day dry weight) for mammalian omnivores = $(0.432[\text{Body Weight in kg*1000}]^{0.678})/1000$;
e, Estimated food ingestion rate (kg/day dry weight) for mammalian insectivores = $(0.373[\text{Body Weight in kg*1000}]^{0.622})/1000$;
f, Estimated based on a soil consumption rate of woodcock of 10.4% (Beyer et al. 1994). If the diet of woodcock is 99% earthworms and 10.4% of its diet is soil, then a robin consuming 40% earthworms would consume 4.2% soil.

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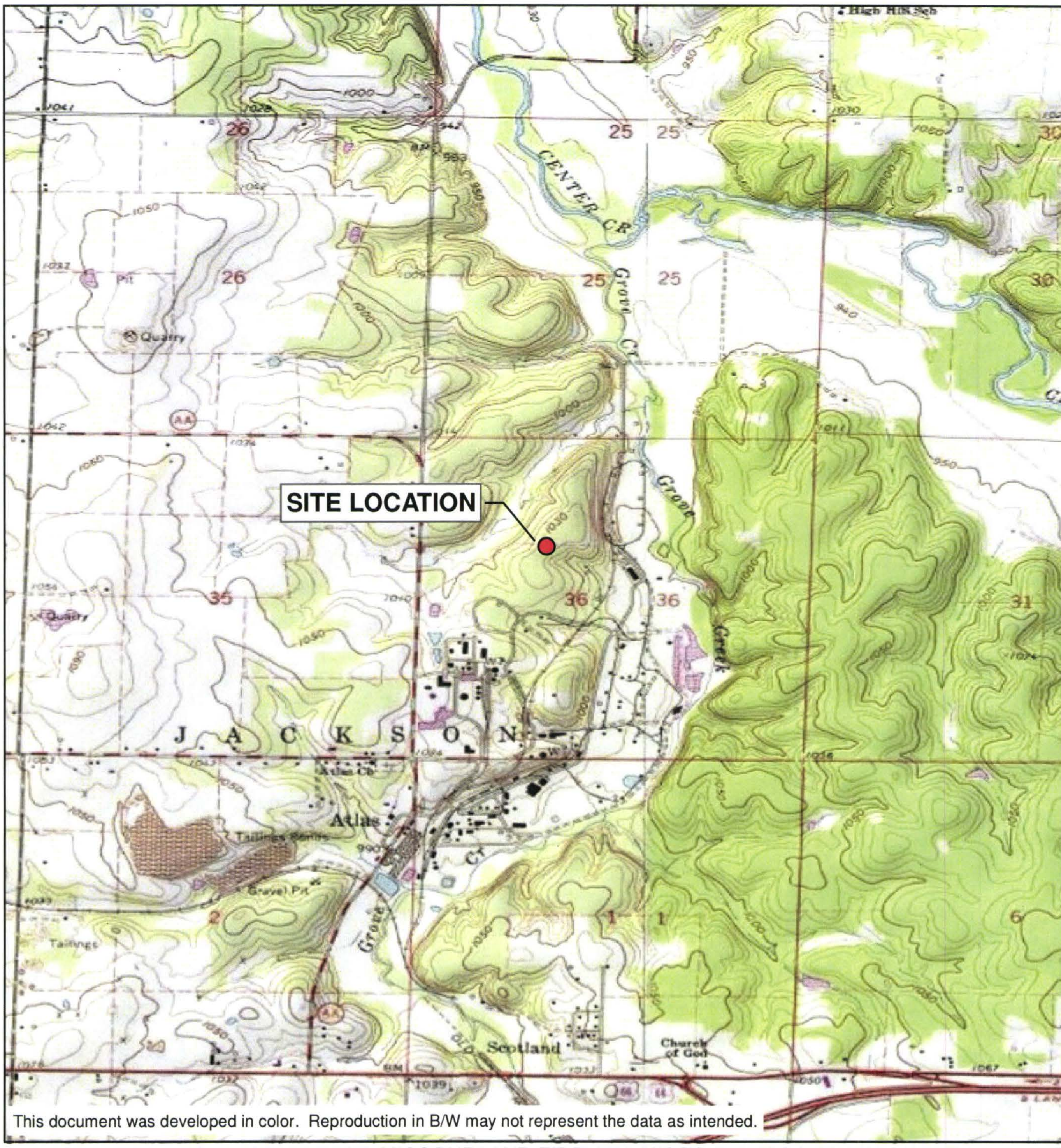


PLOTDATE: 9/5/2012 MLS

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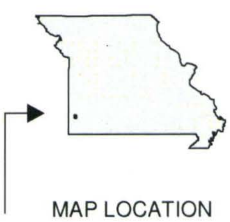


GENERAL DYNAMICS
OTS MUNITIONS FACILITY
JOPLIN, MISSOURI

N

**FIGURE 1**
**SITE LOCATION**

0 1,250 2,500 5,000 7,500 10,000
Feet

SEPTEMBER 2012
49516

1:30,000

O'BRIEN & GERE


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GENERAL DYNAMICS
OTS MUNITIONS FACILITY
JOPLIN, MISSOURI

**FIGURE 2**
**AERIAL PHOTOGRAPH**

0 1,000 2,000 4,000 6,000 8,000
Feet

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GENERAL DYNAMICS
OTS MUNITIONS FACILITY
JOPLIN, MISSOURI

**FIGURE 3**
**FACILITIES DETAIL**

N

0 150 300 600
Feet

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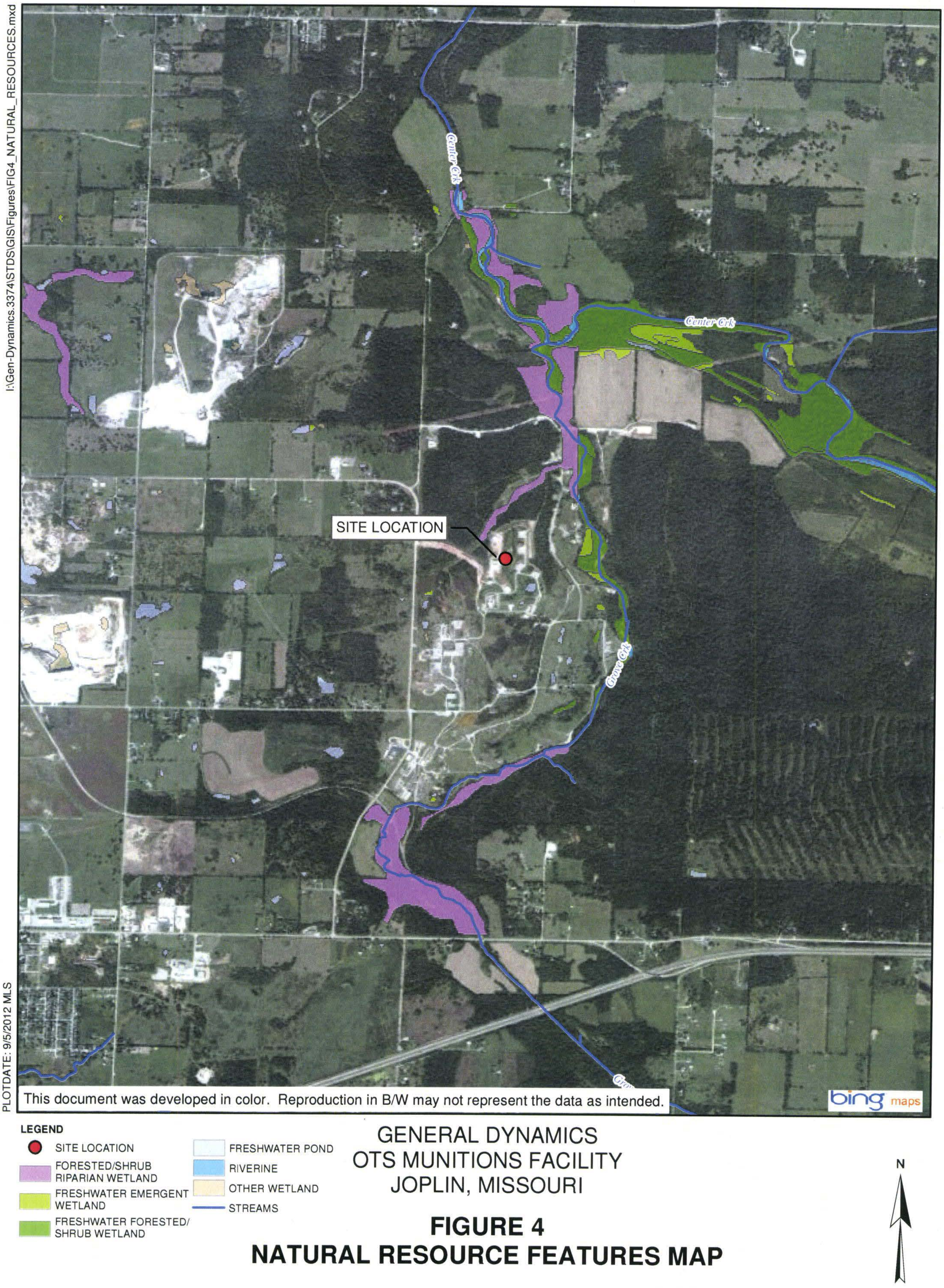


GENERAL DYNAMICS
OTS MUNITIONS FACILITY
JOPLIN, MISSOURI

**FIGURE 4**
**NATURAL RESOURCE FEATURES MAP**

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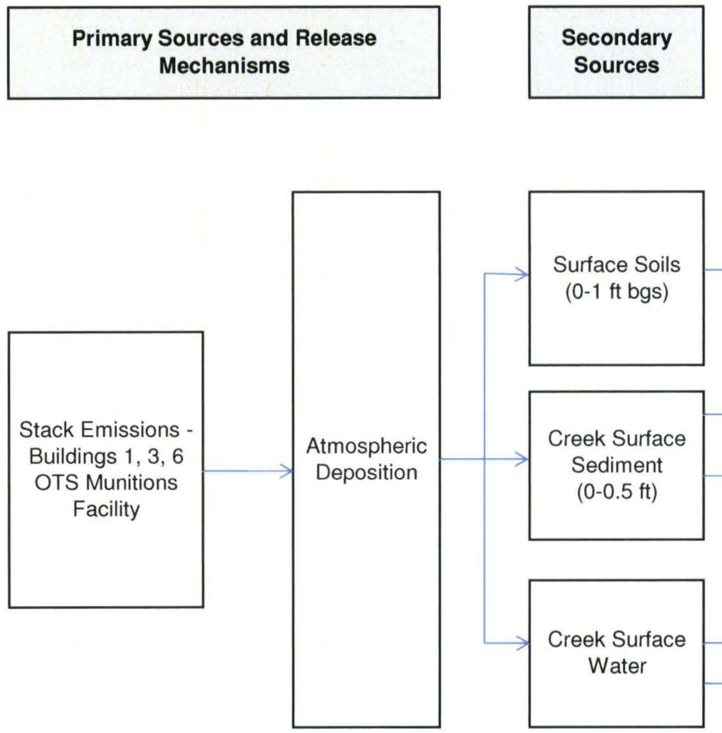
## Figure 5
## Screening Level Ecological Conceptual Site Model
## General Dynamics OTS Munitions Systems Facility
## Joplin, Missouri




| Exposure Media | Exposure Routes | Ecological Receptors - Aquatic Exposure Pathway | | | | Ecological Receptors - Terrestrial Exposure Pathway | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Community Level Receptors | | Wildlife Receptors[b] | | Community Level Receptors[a] | | Wildlife Receptors[b] | | |
| | | Benthic Invertebrates | Fish | Raccoon | Great Blue Heron | Terrestrial Plants | Soil Invertebrates | American Robin | Short-tailed Shrew | Red-tailed Hawk |
| Surface Soil (0-1 ft bgs) | Incidential Ingestion | --- | --- | --- | --- | --- | *de minimis* | C | C | C |
| | Direct Contact | --- | --- | --- | --- | C | C | *de minimis* | *de minimis* | *de minimis* |
| Prey Tissue | Dietary Ingestion | --- | --- | --- | --- | --- | --- | C | C | C |
| Surface Sediment (0-0.5 ft) | Incidential Ingestion | *de minimis* | *de minimis* | C | C | --- | --- | --- | --- | --- |
| | Direct Contact | C | C | *de minimis* | *de minimis* | --- | --- | --- | --- | --- |
| Prey Tissue | Dietary Ingestion | *de minimis* | *de minimis* | C | C | --- | --- | --- | --- | --- |
| Creek Surface Water | Dietary Ingestion | *de minimis* | *de minimis* | C | C | -- | --- | --- | --- | --- |
| | Direct Contact | *de minimis* | C | *de minimis* | *de minimis* | -- | --- | --- | --- | --- |

<u>Notes</u>:
bgs = below ground surface

C = This complete exposure pathway will be evaluated for the appropriate measurement endpoint.
--- = exposure pathway not complete for the indicated receptor.
*de minimis* = potentially complete pathway but not evaluated in the SLERA because exposure is expected to be insignificant.

a = Measurement endpoint for lower trophic level receptors is a comparison of estimated abiotic media concentrations to conservative medium-specific benchmarks/criteria.
b = Measurement endpoint for upper trophic level receptors is a comparison of calculated average daily doses to wildlife toxicity reference values.

# *Detailed Facility Description*

# B. PART B PERMIT APPLICATION REQUIREMENTS

## SECTION 1

## 1.0 GENERAL FACILITY DESCRIPTION

This section of the permit application contains a general facility description as required by 10 CSR 25-7.270(2)(B) and 40 CFR 270.14. The information provided is supplied to acquaint the reviewer and the permit writer with an overview of the facility. Specific areas of the facility are described in greater detail throughout this document. The Table of Contents can be referenced to identify these locations.

### 1.1 OWNER AND OPERATOR

EBV Explosives Environmental Company dba General Dynamics Ordnance and Tactical Systems Munition Services (GD-OTS MS) is the owner and operator of the reactive waste Treatment, Storage, and Disposal Facility (TSDF). GD-OTS MS is owned by General Dynamics Ordnance and Tactical Systems, St. Petersburg, FL.

| Physical Address: | Mailing Address: |
|---|---|
| General Dynamics OTS Munition Services4174 | General Dynamics OTS Munition Services |
| County Road 180 | P.O. Box 1386 |
| Carthage, Missouri 64836 | Joplin, Missouri 64802 |

### 1.2 FACILITY DESCRIPTION

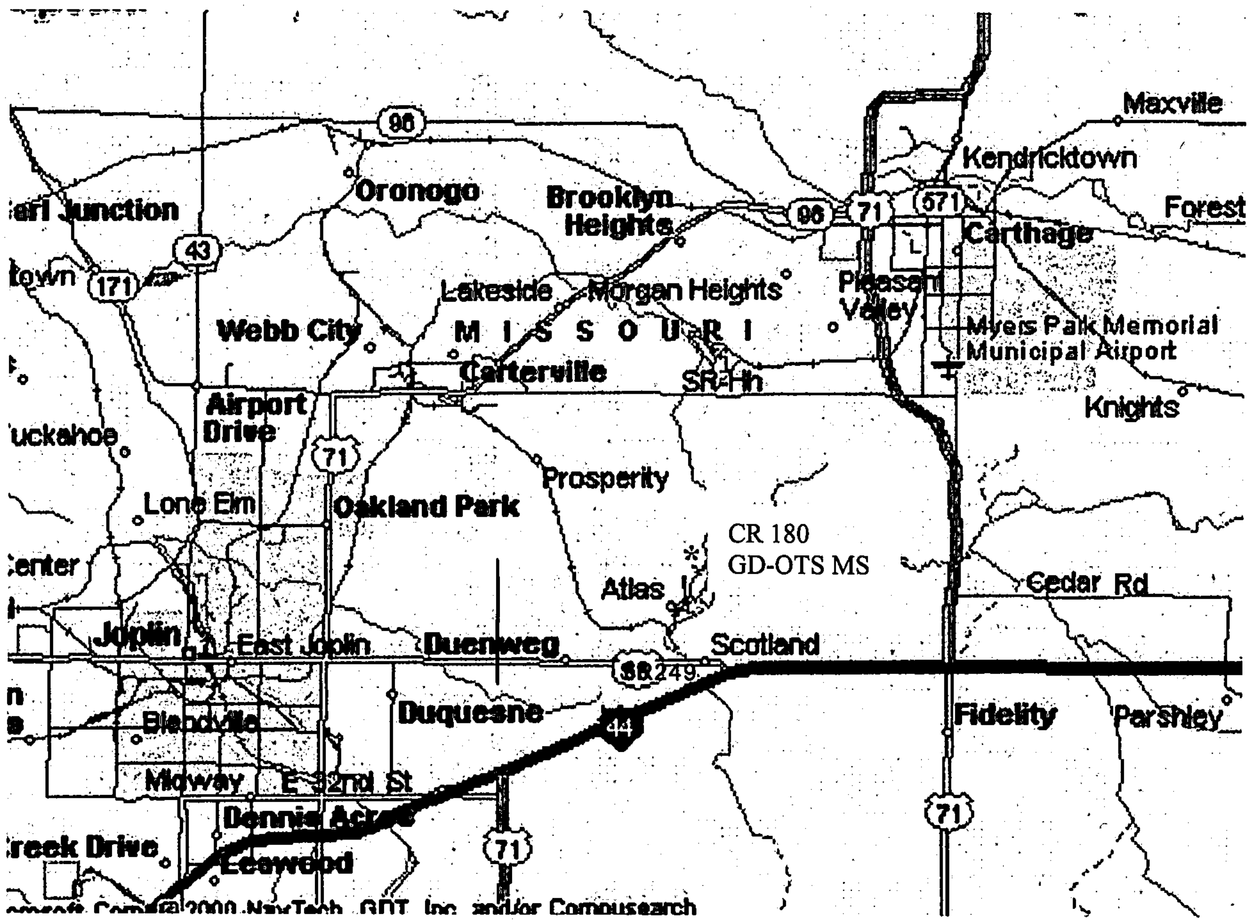
The TSDF owned and operated by GD-OTS MS is located at 4174 County Road 180, Carthage, , Jasper County, Missouri. Figure 1-1 shows the facility location on the Missouri map and Figure 1-2 shows the facility location on the Joplin/Webb City Area Map. Figure 1-3 shows the complete GD-OTS MS Facility.

Figure 1-1

GD-OTS MS Facility Location Within Missouri

Figure 1-2

GD-OTS MS Facility Location On Joplin/Webb City Area Map



The GD-OTS MS Facility consists of numerous operating buildings and areas, and storage magazines, located within a 55-acre site. The Operations Area and Magazine Storage Area are within a fenced area. Access into the Operations Area and Magazine Area is via the Main Plant Outer Gate off of County Road 180, as described in Section 3. The main parts of the Facility are shown on Figures 1-3 and 1-4, and are listed below with a brief description of each.

- Administrative Office and Main Security Gate
- Building No. 1 MLRS/ICM Disassembly Building
- Building No. 2 MLRS Download and Disassembly Building
- Building No. 3 Propellant Thermal Treatment Process
    - Preparation Bay
    - Rocket Motor Saw Bays
    - Transfer Room
    - Propellant Thermal Treatment Chambers
    - Air Pollution Control System

  Building No. 4 CBU Disassembly Building
- Building No. 5 Storage/Feed Handling Building
- Building No. 6 Incineration Complex
    - Control Room
    - Feed Room
    - Kiln Containment Room
    - Residuals Handling Room
    - 90-Day Storage Area
    - Air Pollution Control System Area
    - Induced Draft Fans and Stack Area
    - Continuous Emissions Monitoring Building
    - Car Bottom Furnace Room
    - Utilities Building
- Building No. 8 Field Office/Change House

  Building No. 9 Maintenance Shop

  Building No. 10 Water Well Building
- Magazine Area (Magazine Nos. 1, 2, 3, and 4)

### 1.2.1 Administrative Office and Main Security Gate

The Administrative Office and the Main Security Gate (Gate No. 1-see Figure 1-5) are located adjacent to each other. The Administrative Office houses management, clerical, financial, recordkeeping operations, and environmental management functions. All regulatory agency personnel visiting GD-OTS MS will check in at the Administrative Office. The Main Security Gate is where all traffic entering and exiting the GD-OTS MS Facility is controlled. When an incoming load of waste is received, the truck driver will sign in at the Main Security Gate, and then will be escorted to the Main Plant Outer Gate (Gate No. 2). Details of the handling of shipments of waste and associated traffic management are detailed in Section 3. Procedures for receipt of waste shipments involve verification of manifests, waste sampling and fingerprinting. Details are contained in Sections 3, 4, and 7.

### 1.2.2 Building No. 8 Field Office/Change House

The Field Office/Change House is located outside of, but adjacent to the GD-OTS MS Plant Operations Area. It houses supervisor offices, the maintenance office and work area, the employee lunchroom, instrument calibration and repair laboratory, employee change rooms, showers, and restroom facilities, and a laundry room. All personnel in the Field Office directly support Plant operations and Magazine storage operations.

### 1.2.3 Building No. 1 MLRS/ICM Disassembly Building

The MLRS/ICM Disassembly Building consists of two separate parts, a non-RCRA regulated disassembly area, and a RCRA Subpart X thermal treatment area. In the non-RCRA area, military munitions are downloaded in safety cells and the submunitions disassembled using unattended, automated equipment to remove and disassemble the submunitions. Disassembled submunitions are subsequently thermally treated in the RCRA Subpart X area of the building.

The RCRA Subpart X thermal treatment area consists of four Contained Thermal Treatment Chambers (CTTC) where the explosives in the submunitions are ignited by natural gas fired torches and allowed to burn in the chambers. There also are four electrically-heated Static Kilns (SK) in which the fuzes from the submunitions are thermally treated. Emissions from the thermal treatment of the explosives in the submunitions and fuzes are controlled by APCSs servicing the thermal treatment processes. Additional detail of this building and processes is contained in Section 10.

The Contained Thermal Treatment Process includes four Contained Thermal Treatment Chambers (CTTC) and four Static Kilns (SK), all of which are RCRA Subpart X miscellaneous units. The body of the submunition contains 17% (30 grams) of explosive material and no RCRA regulated chemicals. The submunition body is placed in a fixture on a conveyor that runs through a CTTC. The explosive material in the body is ignited by a natural gas fired torch and allowed to burn. All of the explosive material in each body is consumed in about 1 minute. Clean scrap metal is collected in the residuals area of this process. The chambers are held at a negative pressure by an induced draft fan on the Air Pollution Control System (APCS) through which the emissions are pulled for cleaning. The CTTC APCS consists of a Primary Cartridge Filter, and a H13 HEPA Filter to remove the very small amount of particulates that are generated by the burning explosives, and an Induced Draft Fan to pull all emission from the chambers thru the APCS to the Stack.

The second part of the submunition is the fuze that contains <1% (88 milligrams) explosive material with less than 0.38% lead. This fuze is conveyed into a separate chamber where it is dropped into an electrically heated SK. The heat from the electric heater on the outside of the SK causes the explosive materials to ignite. The emissions from the burning of the explosive material may include a minute amount of lead, which is pulled into the SK APCS for cleaning. Since the SK is a batch type unit, GD-OTS MS has four SKs with the emission going to the APCS referenced above. Only one SK is operated at a time. While the one kiln is in operation and reaching filling capacity, a second SK is heated in preparation for receiving the fuzes for thermal treatment. A third SK would be in the process of cooling down from completion of a batch treatment prior to opening the SK and removing the metal residue. A fourth SK is used as backup during routine maintenance of the SKs. The APCS for the SKs is a Primary Cartridge Filter and H13 HEPA Filter, with an Induced Draft Fan to pull all emissions from the SKs through the APCS to the Stack.

### 1.2.4 Building No. 2 MLRS Download and Disassembly Building

The MLRS Download and Disassembly Building is a non-RCRA regulated building used for downloading of MLRS rockets from shipping/firing pods, and separation of the warheads and rocket motors. Explosive components removed from the rockets in this disassembly operation are subsequently declared as hazardous waste and are processed through the Building No. 6 Incineration Complex. The warhead is transported to Building No. 1 for additional download and disassembly. The rocket motor is declared as hazardous waste and subsequently processed for disposal in the Building No. 3 Propellant Thermal Treatment Process.

### 1.2.5 Building No. 3 Propellant Thermal Treatment Process

The Propellant Thermal Treatment Process is a RCRA Subpart X regulated building and process for disposal of the MLRS rocket motors. It consists of a Preparation Bay, two Saw Bays, a Transfer Room, two Propellant Thermal Treatment Chambers (PTTC), and an Air Pollution Control System (APCS). The Rocket Motor contains 216.5 pounds of a case bonded Ammonium Perchlorate based propellant. In this building and process, the MLRS rocket motors are cut into segments using underwater saws. The cut segments are transferred from the saw bays into a Transfer Room, then into one of the two PTTCs where they are ignited using a natural gas fired torch. The torch ignites the propellant which is allowed to burn in the rotary conveyor inside of the PTTC. Clean scrap metal is collected in containers. The chamber is held at a negative pressure by an induced draft fan on the APCS through which the emissions are pulled.

The APCS consists of a Quench Chamber to cool the gases and to inject the sodium bicarbonate to neutralize the chlorine and acid gases, a Reaction Chamber (former Spray Dryer) to increase the neutralization and where activated carbon is injected for organics removal, a Baghouse to filter the particulates and a Wet Scrubber to complete the neutralization and particulate filtration of the exhaust gases. An Induced Draft Fan pulls all emission from the chambers thru the APCS to the Stack. Figure 1-3 shows the location of the new unit, Figure 19-3 shows the layout of the building and Figure 19-4 shows the layout of the APCS.

### 1.2.6 Building No. 4 CBU Disassembly Building

The CBU Disassembly Building is a non-RCRA regulated building where Cluster Bomb Units (CBU) are disassembled to remove the multiple bomblets from the dispenser. The bomblets are conveyed into a safety cell consisting of 12" reinforced concrete walls. In the safety cell, the bomblets are disassembled by automated, unattended equipment which opens the bomblets and removes the fuzes. The bomblet halves and fuzes exit the safety cell where they are packaged for subsequent transfer and incineration in the Building No. 6 as hazardous waste.

### 1.2.7 Building No. 5 Storage/Feed Handling Building

The Storage/Feed Handling Building (SFHB) is a storage and containment structure which includes multiple concrete-walled bays and safety cells. Siting is based on safety considerations as specified by the DoD Quantity Distance Tables. The structure is located approximately 290 feet from the Incinerator and associated air pollution control system (APCS) equipment. The SFHB is where desensitization/disassembly/repackaging/staging operations take place. The purpose of these operations is to render materials with unusual hazards, less hazardous to handle, feed or burn. Additional details of the SFHB can be found in Section 9.

### 1.2.8 Building No. 6 Incineration Complex

The Incineration Complex consists of two incinerators regulated by MACT. The hazardous waste handling operations are performed in accordance with RCRA regulations. The Incineration Complex consists of a Control Room, Feed Room, Kiln Containment Room, Residuals Handling Room, 90-Day Storage Area, Air Pollution Control System Area, Induced Draft Fan Area, Controlled Emissions Monitoring Building, Utilities Building, and Car Bottom Furnace.

The Control Room is where the incineration process and feeding operations are controlled for the Rotary Kiln Incinerator (RKI) and Car Bottom Furnace (CBF). This room is adjacent to the Feed Room and the Kiln Containment Room, separated by concrete blast walls. All operational controls for the incineration plant, consisting of a redundant Distributed Control Systems (DCS), are located in the Control Room. Plant operators observe the kiln feeding operation via CCTV monitors. In addition, the Control Room monitors all other operations in the Plant Operations Area using CCTV monitors, including operations at the Magazines. There are numerous CCTV Cameras located throughout all of the plant operations. Multiple monitors are located in the Control Room by which plant operations are monitored.

Waste from magazines or from the Storage/Feed Handling Building is loaded onto a transport vehicle for carrying the waste to the Feed Room. A maximum volume of waste sufficient for up to four hours of incineration operation will be moved at one time. The unloading area is covered by a metal roof. The unloading pad is concrete with berms to contain all spills. Wastes are introduced into the RKI from the Feed Room.

The Kiln Containment Room houses the charge conveyor, the RKI, and portions of the feed conveyor and the discharge skip hoist.

The Residuals Handling Room contains a vibrating conveyor for separating the ash and metals discharged from the RKI. Metals are recovered for recycling and ash is collected for disposal as hazardous waste in a permitted HW landfill

The 90-Day Storage Area is a bermed concrete pad within a three-sided metal building. A drain from the concrete pad is connected to the Air Pollution Control System (APCS) Area collection sump to control spills and precipitation. Ash residuals for disposal are dumped into ash roll-off containers for transport to an off-site, permitted, hazardous waste landfill for disposal. A residuals sampling program is utilized to ensure proper disposal of all residuals. Residual metals are inspected in this area to ensure they have been inerted by the incineration process. Residual metals are dumped in roll-off bins for removal from the site and transport to commercial recycling facilities.

**Air Pollution Control System (APCS) Area**

The APCS area includes the Secondary Combustor, Spray Dryer, Baghouses and support equipment. After exiting the RKI, the exhaust gas enters the Secondary Combustor, where the gas is heated to 1800 - 2200°F by burning natural gas auxiliary fuel. This elevated temperature, in conjunction with the gas residence time of greater than four seconds, ensures the complete destruction of organic materials. After exiting the Secondary Combustor, the exhaust gas then enters the Spray Dryer into which soda ash slurry is sprayed to remove acid gases as well as to cool the exhaust to the operating temperature range of the Baghouse. The exhaust gases leaving the Spray Dryer are then sent to the Baghouses. The dust collected on the bags is removed by reverse pulses of compressed air being applied to the inside of the bags. The dust falls to the bottom of the baghouse where it is removed through a rotary valve. The dust is placed in the ash roll-off and sent to a RCRA approved hazardous waste landfill.

All of the APCS equipment is located on a curbed concrete pad which is sealed with an epoxy coating to prevent leakage of water from the pad. Rain water and any other water that falls on the APCS pad flows into the Sump where it is pumped into Tank TK-103 from which it is pumped for use in the spray dryer as quench water. In this manner, no liquid effluent from the APCS leaves the plant.

Two parallel induced draft fans are provided to move the exhaust gas to the stack. Each fan is designed to handle 100 percent of the total gas flow. Both fans are generally operated at the same time, unless it is necessary to shut down one of the fans for maintenance. The stack is 65 meters in height.

The Continuous Emissions Monitoring Building is located at the base of the stack. Located in the building is the sampling equipment that continuously monitors the stack gases for CO in ppm, Hydrocarbons in %, $O_2$ in %, opacity in %, stack flow rate and temperature.

**Car Bottom Furnace (CBF)**

The Car Bottom Furnace is a natural gas fired incinerator designed to decontaminate large, unusual or irregular shaped metal pieces and incinerate contaminated combustible materials such as rags, coveralls, and packaging materials. The furnace system consists of a Car Bottom Furnace, Overhead Hoist, Car Bottom Furnace Track Scale and a Car Bottom Furnace Baskets.

The Utilities Building houses the Soda Ash Tanks where soda ash is mixed and metered to the spray dryer in the APCS for acid gas control. It also houses the air compressors that provide compressed air supply for operating the plant, an emergency backup generator for supplying electricity to allow an ordered shutdown of the plant in the event of an electrical power failure, and the electrical motor control center.

### 1.2.9 Maintenance Shop

The Maintenance Shop is a non-RCRA regulated building housing maintenance equipment, operations, and supply of parts and materials for maintenance support of all of the plant operations and buildings.

### 1.2.10 Magazine Storage Area

All explosive wastes are stored in the four aboveground storage magazines in the Magazine Storage Area. The magazines meet DoD, ATF, and EPA construction, storage, and security standards. All magazines are used for storage of explosive solids, reactive wastes and DoD materials, as needed. Waste compatibility is maintained in each magazine. The containerized wastes are stored in in accordance with 40 CFR 264.177. Because of the explosive nature of the waste materials, many of which are military munitions, safety requirements of DOD 4145.26-M, "DoD Contractors; Safety Manual for Ammunition and Explosives", regarding waste compatibility, container type, and quality limits are followed in meeting storage compatibility requirements. The net explosive weight of waste in storage, per magazine, at any time will not exceed 100,000 lbs.

## 1.3 WASTE DESCRIPTION

GD-OTS MS is a commercial demilitarization, incineration, and thermal treatment facility to service the explosive manufacturing industry, government agencies such as DoD, and other firms that produce or use materials that are considered reactive or explosive. Most waste received at the Facility is off-specification explosives or explosive containing devices, pharmaceuticals containing explosives, riot control materials, ammunition and propellants. Residual wastes from spill cleanups, plant manufacturing wastes, and related explosive industry wastes are also accepted.

## 1.4 WATER SUPPLY

Water for GD-OTS MS plant operations is supplied from a 35,000 gallon vertical storage tank. The tank is maintained at a level between 85% and full. Plant water well provides resupply water to the tank in excess of the largest single plant demand. The GD-OTS MS Facility fire water supply is a buried 6" line circling the incineration plant. Line pressure is 60 psi. Water is supplied to all process buildings as needed, from the water supply system.

## 1.5 FIRE CONTROL

Fires involving explosive/reactive waste (i.e., ammunition and explosives) will not be fought. The industry-wide procedure of not fighting explosive/reactive waste fires is based on the need to protect human life. GD-OTS MS follows the Institute of Manufacturers of Explosives "Safety

Publication Number 4" and the DOD4145.26M, "Contractors' Safety Manual for Ammunition And Explosives" guidance in not fighting explosive/reactive waste fires. The Duenweg Volunteer Fire Department (DVFD) provides fire fighting services to GD-OTS MS in areas where fire fighting is permitted, which would essentially consists of grass and brush fires away from explosives buildings. Fire hydrants in the GD-OTS MS Facility are compatible with the DVFD fire equipment. In addition, all buildings are constructed in a fire proof manner with steel and concrete construction, (see Section 2) and all brush and trees are cleared, and height of grass is controlled, for a distance of at least 50 feet from each magazine and buildings. The 50-foot clearings around each magazine, including the 15 foot graveled areas adjacent to the magazines, function as fire breaks. Additional specifics regarding fire prevention and fire control are described in the detailed Contingency Plan in Section 6.

**1.6 SURROUNDING LAND USE AND WATER**

The property directly surrounding and within at least 1000 feet of the GD-OTS MS Facility, in all directions, is owned by Expert Management, Inc. (EMI) . Much of this property was originally used for the manufacturing of commercial explosives. However, all operations on EMI property have been discontinued, all facilities have been demolished, and the land returned to its natural state for the most part. The EMI property is currently undergoing environmental remediation or awaiting approval of remediation plans. Surrounding the EMI property, the land can be characterized as agricultural crop land and pasture, urban or built-up industrial, mixed rangeland and mixed forest land. There are some small residential areas; however, the majority of the surrounding properties are small to mid-sized farms.

Water courses nearest the GD-OTS MS facility include Center Creek, Grove Creek, some minor unnamed tributaries to the above-named creeks and some small unnamed ponds, none of which are within 1000 feet of the GD-OTS MS Facility. Grove Creek flows through the EMI property, and is less than one-half mile from the location of the GD-OTS MS Facility. There are no injection wells on the GD-OTS MS Facility, or within 1000 feet of the GD-OTS MS Facility. No fluids from the GD-OTS MS Facility are injected into underground wells. There is one withdrawal wells for providing the plant water supply located on the GD-OTS MS Facility. Location of the well is shown on Figure 1-3.

## 1.7 WEATHER-RELATED DESCRIPTIONS

The Joplin area is characterized by four separate and distinct seasons. Winters are cold and windy, with some snow accumulations. Spring is wet with moderate temperatures and numerous rainfall events. Summers are hot and muggy with sporadic thunderstorms and, on rare occasions, tornadoes. Fall is often drier with lowering temperatures. Meteorological data collected at the Joplin Regional Airport between 1973 and 2006/2007, obtained from the National Weather Service, is presented as wind roses (Figure 1-7) for each month of the year. The wind roses show distribution of wind direction per month at a site for the entire 24 hours. It shows the percentage of time the wind is from a certain direction using the rings and the color indicates what percentage of time the wind speed is from that direction. The top of the wind roses is north.

**Figure 1-7**
**Wind Roses From National Weather Service Data From The Joplin Regional Airport – 1973-2006/2007**

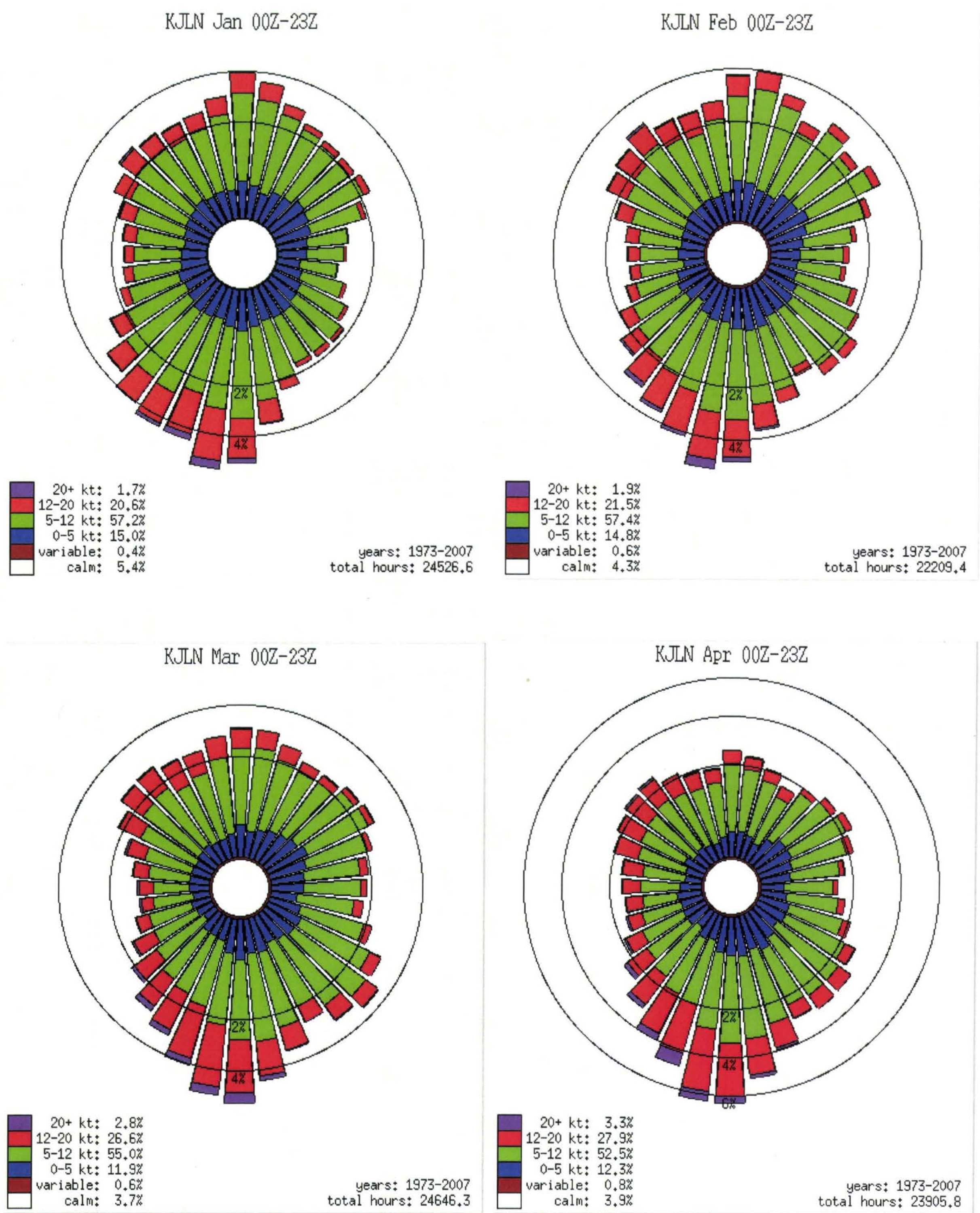


**Figure 1-7 (Continued)**
**Wind Roses From National Weather Service Data From The Joplin Regional Airport**
**1973-2006/2007**

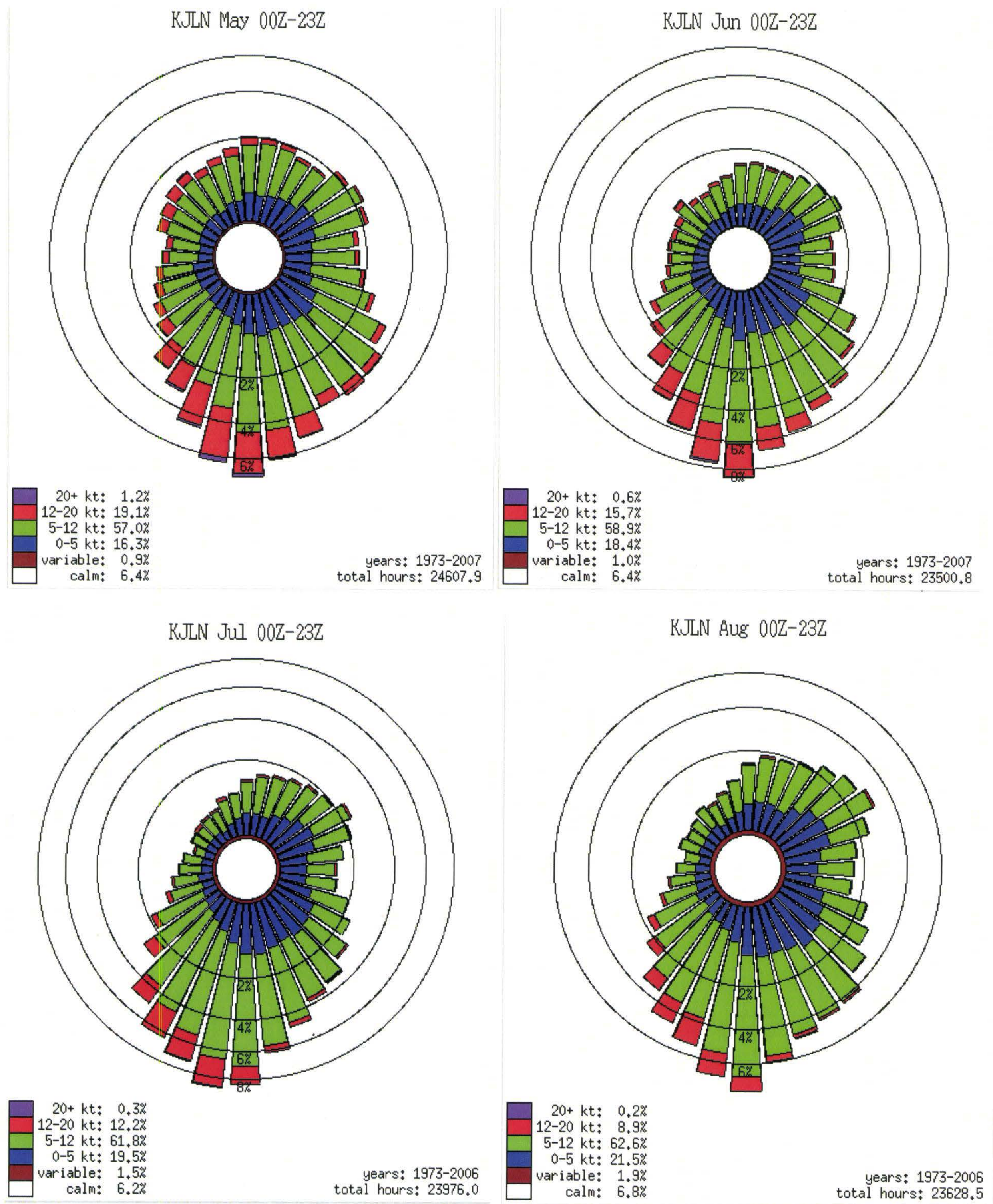


**Figure 1-7 (Continued)**
**Wind Roses From National Weather Service Data From The Joplin Regional Airport**
**1973-2006/2007**